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The Journal of HEREDITY

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OCTOBER, 1924

GEORGE KENNAN
DAVID FAIRCHILD

THE SIZE OF COLLEGE FAMILIES
S. J. HOLMES

SPORELINGS OF FERTILIS BOSTON FERN
RALPH C. BENEDICT

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INHERITANCE OF SHORT THUMBS
R. A. HEFNER

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GEORGE KENNAN AT FOUR AND GEORGE KENNAN AT SIXTY-THREE

The inquiring little boy of four becomes a great friend and interpreter of the Russian and the Japanese peoples at a most remarkable period in their political history.

GEORGE KENNAN

The Inborn and Acquired Characteristics Which Made Him a Great Explorer of the Russian People

DAVID FAIRCHILD

TO KNOW that a human heart has stopped, a heart whose beatings have nourished the brain which stirred the emotions of millions of men and women, formed their opinions and aroused the sympathy of whole peoples, makes one question the accuracy on our scientific ideas of space and power and time.

The thought that so vast a brain as that of George Kennan, which bound in such a firm grip of accurate memory events stretching back to the Civil War, can go out of existence, so that in a few moments, vast arrays of priceless abstractions, countless thousands of observations, collected through three-quarters of a century, can drift completely beyond the reach of the world of thinking beings, appalls one with its waste of energy.

Yesterday a question could unlock this vast storehouse of knowledge; today the storehouse is locked.

When an average man of seventy-nine dies, his own friends mourn him, but when a mind like that of the late George Kennan comes to a standstill, the civilized life of man loses a store of real knowledge which can never again be gathered together.

To live for seventy-nine years and witness the change from a world which had just discovered kerosene to one which uses wireless telephony is something in itself. When, like George Kennan, a man has been in touch for many of these years with the greatest leaders of thought in three vast continents, whether with political criminals in exile or chief executives in the White House, and when added to this he has been an active observer of five great wars, of a volcanic eruption, an earthquake, and has had personal acquaintance with great Oriental statesmen and vast Oriental peoples, the array of his experiences becomes almost fantastic.

To have been the chief intellectual link between America, Europe and Russia for fifty years, to have championed the cause of thousands of doomed political prisoners exiled to the mines of Siberia, and interested millions of Americans in their lot was almost like writing an *Uncle Tom's Cabin* of Russian oppression.

George Kennan was a peculiarly lovable man and a remarkably attractive one. I think what held one's interest from the first meeting with him was the vividness of his conversation, the sharpness of every outline of the thousands of word pictures with which his conversation was filled. One felt, too, the well balanced judgment combined with profound thinking, the result of long hours alone, and the vast experiences of a great world explorer who, for over half a century, had kept in touch with all the great natural and human happenings of the whole globe.

How faintly we appreciate the vast distinction between the literature of opinion and the literature of knowledge, and how the one fills books with fragile theories and hypotheses, and the other with the stones out of which the structure of our civilization is built! The little boy of six years, George Kennan, who played with his father's telegraph instrument in the village of Norwalk, Ohio, was an accumulator and an analyzer of his observations. He was interested in getting at the facts.

I did not know him as a boy, but it

is not conceivable to me that he was then different in kind from what he was at seventy-nine. For during the last month of his life, his brain had the alertness and the curiosity of a boy's. He seemed to have none of the usual indifference of old age. If he looked at a thing, it was with the idea of understanding it. If he questioned you, it was because he was interested in what you said—interested to find out if it was so, and interested to see how what you said fitted in with what he knew.

Mr. Kennan said to me once during a very intimate conversation in his study in Medina: "I have always tried to do what I thought was worth doing as well as I possibly could," and I believe that everything he wrote, even the letters to his friends, shows this life-long attempt to make every word he used be unmistakably the right word to give just the meaning he intended.

He did not believe in using words loosely any more than a Florentine mason in the time of Michaelangelo believed in using the tiles of his mosaics at random, and George Kennan's writings might be compared with those mosaics in the monasteries of Florence, with this vast difference, however; his were generally made with the purpose of arousing men to action in this world, and theirs dealt with the world to come.

His adventures were thrilling, and they were experiences encountered during the course of his investigations rather than sought-after excitements. He wrote because he wanted people to know what he had discovered—not because he wanted to be known as a writer. I know of no more thrilling story of real danger than that in his "*Tent Life in Siberia*," where he describes being swept by a storm at night out into the Okotsk Sea in a small boat, and having a line thrown him from the deck of the steamer he was trying to board, just as his mastless, helpless boat disappeared into the darkness astern of her. If any man has heard Mr. Kennan tell how he was once lost in a Siberian blizzard and sat on his heels all night in its blinding sleet with the temperature at fifty below zero, he has an accurate word picture of the hardships of Arctic travel in Siberia.

How much his ability was an inborn one, and how much a talent developed through his ambition to make his word pictures accurate will be hard to determine, but I doubt if anyone more persistently trained himself to take note of every detail to be seen around him. Wherever he traveled, in the swamps of Cuba, across the jungle trails of Central America, on the precipitous passes of the Caucasus, on the ash-covered volcanic cone of Mt. Pelee, in the frozen tundra of Siberia, or on the mountain slopes of the Altai, he carried an accurate system of note taking, so that whatever he wrote afterwards about the places he had traveled through was as accurate as he could make it and as full of detail as if it were written with the scene before him. I doubt if any other explorer has ever excelled Mr. Kennan in the correctness of his word pictures and in their vividness.

He once explained to me that if, for instance, he strolled for the first time into a city square, he jotted down in his notebook first the most striking objects, such as the church, the city hall, the market, next the less obvious characteristics of the square, but those which a brief survey would make apparent, and last, the minute details, such as the character of the bricks, or the paving stones, or the ornamentation on the fountain. With these facts in his notebook to refresh has marvelous memory, he was able to paint word pictures so vivid that they have remained for fifty years in the memories of thousands of people.

One of the most extraordinary tributes I have ever heard paid to a lecturer was that recently paid to Mr. Kennan by a man who had heard his lecture on the Caucasus thirty years ago and who complimented him on the splendid pictures he had shown at that time. As a matter of fact Mr. Kennan had never taken any photo-

graphs of the Caucasus and it was his marvelous word-pictures alone which had made his auditor feel he had seen the places Mr. Kennan described.

The range of Mr. Kennan's interest always attracted me. I remember the persistence which finally landed in his little garden a black lily he had noticed on the mountains of the Altai forty years before. I once found him carefully lifting a clump of bloodroots in his garden in Baddeck, Nova Scotia, taken there from my place, "In The Woods" in Maryland, which he wanted to send to his new home in Medina, New York. Or, I can see him as he was last winter, at seventy-nine, erect and excited, at my home in Cocoanut Grove, telling a group of us how he had stood, forgetful of all danger, awed by the magnificent spectacle, watching the smoke cloud from Mt. Pelee mount upward ten thousand feet into the air.

I can see his eyes fill with tears as he showed me the letter from a poor friend of his in Petrograd, wife of a banker who was kind to him when he was hunted by the police in Russia, and I have listened to his description of a scene in a primary school in Japan in which the teacher used papier maché models to illustrate the parts of a flower. I can still visualize from his graphic account the strange phenomenon of the "milk sea" which he once witnessed in the orient.

He was also a great traveler in that he escaped forming a blind side to what he saw from a car window. If there flashed by a meadow, golden with yellow flowers, he did not dismiss the fact from his mind by the deductive method and call them buttercups when they were dandelions. If black and white cattle browsed in the meadow, he was interested to know of what race they were. If the train passed through a forest, to him it was a forest of black spruce or Georgia pine, not merely a forest of nameless evergreens. There were none of those blurred artistic outlines in his landscapes which make so much modern fiction distasteful to a naturalist.

I have always been interested in the environment of a new idea and was much impressed by Mr. Kennan's once telling me that no matter where he was, if a phrase came to him which seemed to express some interesting new idea with peculiar clearness, he always jotted it down at once, for it was his experience that unless he did so, the exact combination of words which had come to his mind seldom occurred to him again. I feel convinced that with most of us many a rare idea is laid away and forgotten in the mistaken notion that we can at will drag it out again into the light.

But it was perhaps as an interviewer that Mr. Kennan showed his greatest talent. To go, as he did, to Siberia, with letters from the authorities in St. Petersburg to the police authorities in charge of the exile camps and discover, not only that his previous convictions about the system were wrong, but to become the confidant of hundreds of revolutionists, including some of the chiefs of police themselves, and to do this in a country where only Russian was spoken, required not only a thorough knowledge of Russian, a consummate understanding of the Russian people but interviewing ability of the highest order.

How well George Kennan knew the Russian character, and how imperfectly other admirers of Russia knew it came to my notice in a forceful way at the very outbreak of the Kerensky Revolution. The private secretary to the then Secretary of State showed me a cable from his father, who was in Petrograd, in which he heralded as "bloodless" the revolution which had just come. I copied the cable, sent it to Mr. Kennan, and got an instant reply: "The streets of Petrograd will yet run with blood." Before many months had passed the Bolshevik carnage had begun. It will always be difficult to estimate the value to the world of Mr. Kennan's correct analysis of the Russian character, but

that it kept thousands of the best minds in America from falling into the trap of too implicit confidence in the sanity of their soviet theories, there can be no doubt.

As one who has for years listened to his fascinating accounts of this great world, I am overcome by the gigantic loss which this means to my own environment. I have sat with him beside camp fires on the Bras D'Or Lakes in Nova Scotia, been thrilled by his addresses in packed halls, or discussed public affairs by the fireside of his old friend, Alexander Graham Bell. In his study in Medina, New York, or in my laboratory under the palms at Cocoanut Grove, Florida, his was the same dynamic personality. Now that I know I shall never see again those keen, eaglelike eyes, I am conscious that there has dropped out of my life the most fascinating intellect I ever knew.

A Journal of Cell Stimulation

One of the newest additions to the list of biological publications is *Zell-stimulations-Forschungen*, edited by Dr. M. Popoff, professor in the University of Sofia, Bulgaria, and Dr. W. Gleisberg, of the Institute of Plant Physiology of the University of Breslau, Germany. The journal will appear irregularly, three or four issues making up a volume. The publisher is Paul Parey, Berlin S. W. 11.

An introductory statement in the first issue outlines the scope of the publication. While most of the fundamental early researches in cell stimulation were made by men working on artificial parthenogenesis, it is claimed that the results have such a practical application that treatment of seed before planting will soon be a routine operation in agriculture.

The present antiseptic treatment of wounds in animals (including man) must also, it is declared, soon give way to or be supplemented by a stimulating treatment, for the development of new tissue. Again, a practical field for cell stimulation is found in the various operations of budding, grafting, and callus formation that are indispensable in horticulture. Finally, the whole subject of the growth of cancerous tissue naturally falls in this field.

While the journal will deal with all phases of the subject, theoretical and practical, it is apparent that it will lay particular emphasis on the application of cell stimulation to agriculture. Editorial communications should be addressed to Professor Popoff at Kurfuerstendamm 257, Berlin W. 62.

P. P.

THE SIZE OF COLLEGE FAMILIES

A Study of the Size of the Families of College Students in Relation to the Nationality, Religion and Education of the Parents

S. J. Holmes

University of California

THE data upon which the present paper is based were obtained from the records collected by the Department of Physical Education at the University of California. Physical education is required of all regular students at the University, and each male student since 1920 has been requested to fill out a record card on which are entered, in addition to data on his physical history and development, various facts regarding his parents, grandparents, brothers and sisters. The record card, which was devised by Professor Kleeberger and myself, calls for statements concerning the number of children in the family of the student, the number of children in the families of both paternal and maternal grandfathers, the racial stock, country of birth, occupation, religion, and degree of education of parents and grandparents. If the students were unable to supply all these data the required information was secured by correspondence with their parents.

In order to get as full a record as possible of all of the members of the family, it was requested that all persons living or dead (including still births) be reported; and to test the completeness of the family it was requested that the age of the youngest child be given. Very few children below ten years of age were reported, and in less than one per cent of the cases was a child given of an age which indicated that more children in the family were of probable occurrence. Our students are sixteen years or more of age when they enter the University and the birth of other siblings in the classes of parents we are dealing with would not be sufficiently frequent to influence sensibly our results.

The information collected in this way makes it possible to work out a number of relationships between the racial stock, size of family and various physical characteristics and environmental influences. Taken in connection with the data on scholastic standing in the Office of the Recorder, they enable one to work out relationships between the characteristics mentioned and scholarship. Of course, the group studied represents a selected class differentiated in several respects from the general population. But this is a very important class. It is a class which furnishes much of our intellectual leadership and its biological trend is a matter of some moment. A study of the stream of students passing through a large university like our own, would enable us to answer many questions concerning what is happening to one highly important stratum of our population. Were we to study this stream for, say, twenty-five years, on the basis of such data as have now been collected, we should be able to answer such questions as how the racial stock of this class is changing, how the trend of marriage is influenced as regards race, nationality, religion and schooling, what changes are taking place in the birth rate, and what relations exist between the changing ancestry and the physical and mental development of the students. There are various other relationships that might be worked out and it is our hope to present some of them in future studies.

Size of Families of Parents and Grandparents

A comparison of the families of the grandparents of our students with the families of the parents shows, as would

be anticipated from the general decline of the birth rate, that the former were of considerably larger size. They average 5.21 for the former as compared with 3.66 for the latter. The families of the paternal grandfathers (5.25) were a little larger than those of the maternal grandfathers (5.16). This also is probably due to the decline of the birth rate. Since the fathers, as a rule, are a few years older than the mothers, the latter belong to a somewhat later period in which the birth rate is more reduced. The difference in the size of the families is not great, but since it is based on over 42,000 individuals it is very probably not due merely to chance.

In the data on the relation between birthplace of parents and the size of the family, the parents were classed simply as native born and foreign born. It is a well-known fact that the foreign born inhabitants of the United States have larger families than the native Americans. In our selected group which represents parents of more than usual intelligence, the difference in the size of families of foreign and native born is not so great as would be found between these classes in a large city, such as New York. The foreign born parents of students have families exceeding those of the native born by little more than one child. In our material the average number of children is 4.60 for foreign born parents and 3.34 for the native born.

Size of the Families from Which Students Came

In considering the size of the families from which students are drawn it must be borne in mind that, other things equal, students will tend to come from families of more than the average size. The reason for this is purely statistical and the same result would be obtained by taking any other kind of a selected group. Families of no children would not, of course, be represented in our group, and families of large size would, other things equal, be more apt to be represented than a family with few offspring. How much larger are the families from which students come than are the average families in the general social stratum from which students are commonly derived it is impossible to say. We do not know what proportion of marriages are sterile and even if we did know we should need further data to solve the problem.

There are, on the other hand, certain influences which tend to make families of our students small. The largest families would be rarely represented in the group that would be apt to send students to college owing to the negative correlation between fecundity and education. Then, a large family often makes it more difficult to give children educational advantages that might be afforded were there fewer to provide for. It is not probable, however, that these circumstances would compensate for the larger size of our family groups which is due to the method of selection.

Place of Birth and Size of Family

Families in which one member was foreign and the other native born proved to be intermediate in size between the families of native born parents and those of foreign born parents. The number of such families was relatively less than that of either of the other groups, but the intermediate size obtained for each of the five years considered. Marriages in which the father was foreign born and the mother native born are over twice as numerous as those in which the mother was foreign born and the father native born, there being 466 of the former and 181 of the latter. The mixed families in which the mother was native born were a little larger (3.82) than the families in which the mother was foreign born (3.63), but the relationship is reversed for some of the particular years. The marriages between native and foreign born are not indicative of the mingling of distinct racial stocks. As a rule, the person of foreign birth marries into a family of the same nationality. Prob-

ably the fact that there are more mixed marriages in which the male is foreign born is due to the preponderance of males among our immigrants. When we compare the number of students coming from mixed marriages in which the father is foreign born with the number coming from mixed marriages in which the mother is foreign born, we find that the ratio (nearly 3 to 1) is higher than the corresponding ratio in the general population (namely, about 1.8 to 1) according to the 1920 census.

The foreign born elements of our population do not send students to college to so great an extent as do the native born. It may be of interest to compare the college population as regards extraction with the population of California, although the University draws students from many localities outside of its borders. At the last census (1920) California had 1,677,955 native white persons of native parentage. In addition there were 681,622 foreign born whites and 162,150 of other races. In our University population there were in the period covered 3,042 students of native parentage on both sides, 742 of foreign parentage and 647 of mixed parentage. Only a very small percentage of the students are foreign born.

Religion and Size of Family

The data on the relationship between religion and size of family show that in families in which both parents are Protestants the average number of children is 3.48, while the families in which both parents are Catholic the average number of children is 4.44. Those students whose parents' religion is given as Hebrew belong to families intermediate in size, between those of Protestants and Catholics, namely 3.73. One would not be justified in attributing these differences in family size to the influence of religion alone. It is not improbable that the other factors involved are the more important. The Catholic parents are to a considerable degree of foreign extraction. Social status, tradition and education play an important part in determining the differences in the birth supply of these different groups. Differences of status and education may not be so great among families sending students to college as they are in the general population, and it is of interest that a similar relatively high birth rate characterizes our selected group of Catholic adherents. Although the Catholic families have about one more child than the Protestant families, it is probable that their birth rate has been voluntarily limited. So far as Catholic families have been investigated in the general population they run larger than the figure for families of our students, which, as we have seen, is an exaggerated figure owing to the method of selection.

The families of mixed religious affiliations are relatively rare. There were ninety-one in which the father was Protestant and the mother Catholic, and seventy-eight in which the mother was Protestant and the father Catholic. The average number of children in such families was smaller than in the purely Protestant families. Where the father was Protestant the average number of children was 3.16, and where the father was Catholic it was 3.00. This phenomenon has been found in a number of previous studies on the fertility of mixed marriages in Europe, and represents apparently a widespread condition.

In all of our material there are only three cases (less than one per cent) in which adherents of the Hebrew faith married outside of the fold, one of them to a Catholic and two to a Protestant. Protestants married Protestants in over ninety-seven per cent of cases and Catholics married Catholics in over eighty-two per cent of cases. The greater percentage of out marriages among the Catholics is due largely to the numerical minority of this group. If the mixed marriages were between Catholics and Protestants, as most of them were, a given number of such marriages would involve a relatively large percentage of the

numerically smaller group. Protestant parents of our students outnumber Catholic parents nearly seven to one. There is also about seven times as much out marriage among the Catholics as among the Protestants.

Considering the small size of the group it is quite remarkable that the proportion of out marriages among the Hebrews is so small. By no means all people of Jewish blood adhere to the Jewish religion, and it is not improbable that many Jews who marry outside of their religious group are set down as belonging to some other religious organization. Fishberg says concerning the Jews that "the proportion of mixed marriages is larger the less devoted they are to the separative rituals of their religion." European statistics show that the intermarriage of Jews and Christians is increasing, and in Australia in 1901 the proportion of mixed marriages was about forty per cent. Fishberg thinks that the proportion is about as high in the United States, although we have no accurate statistics on the subject. If this is the true proportion our data would seem to indicate that the Jews retain the distinctive tenents of their faith much less in mixed marriages than the Catholics and Protestants. "Available statistical data shows," says Fishberg, "that the children born of Jews married to Christians are nearly all raised as Christians." Perhaps the students resulting from such marriages seldom report one of their parents as Hebrew in religion.

Education and Size of Family

In compiling the data on relation of education to size of family, parents were classified into three groups: common school, high school and college. Parents were classified under these headings no matter how long they attended the schools in question. Normal school students were put into the high school group and those attending professional schools were classed under college. Families in which both parents had merely a common school education were the largest of all, namely 4.17. Where both parents attended high school the average number of children was 3.38, and where both parents were educated in college the size of the family was the least, namely 3.10. There was one family of fourteen children in which both parents were college bred. They were both born and educated in Russia.

The parents of our students exhibit a strong proclivity to assortative mating on the basis of education. The largest group (1,101 cases) is that in which both parents had a common school education. There are many cases (808) in which one parent had a high school and the other common school education, and relatively fewer (261) in which a college graduate marries one whose education is limited to the common school. The college bred tend to marry the college bred (473 cases), but it is rather more common for the college bred man to marry the high school girl (710 cases). The reverse matings are relatively less frequent. Taking the parents of one sex from any of the three categories, the size of the family diminishes as the degree of education of the other parent increases. Thus the high school girl who marries a common school man has on the average a family of 3.55 children. If she marries a high school man she has 3.38 children, and if she marries a college man, 3.24 children. If we take the high school man the size of his family decreases as the education of his wife increases. If she is a common school girl she has 3.89 children, if a high school girl she has 3.38 children, and if she has attended college she has only 3.14 children. Whether we select the one or the other sex from any of three groups we find that the figures tell precisely the same story.

The results indicate that education has a potent effect in reducing family size whether it is possessed by the male or female parent. The education of the mother apparently has a somewhat closer association with family limitation, however, than the education of

the father. Where the mother has a high school education and the father a common school education, the average size of the family (3.55) is less than when the mother is educated in the common school, and the father is educated in the high school (3.89). Where the father has a common school education and the mother is college bred the family is smaller (3.35) than when the mother has only a common school education and the father is college bred (3.44). Similarly where the father has a high school education and the mother a college education the family (3.14) is smaller than when the mother is a high school girl and the father is educated in college (3.24). The results are in entire agreement in indicating that superior education is more closely associated with family restriction in the female than in the male. This is probably due to a considerable degree to age, since the less education the wife has the younger on the average will be her age at marriage, and it is well known that early marriages favor the production of large families. The factor of age at marriage is much more important in the mother than in the father. Relative youth rather than relative education may be the chief reason for the association in question.

In order to study the distribution of families of different size, a compilation was made of the number of families containing one, two, three, etc. children. For the Protestant families the modal, or most frequent number, is two. The same holds true for the Catholics, although in this group there are relatively fewer families with but a single child and relatively more with five, six, seven or more children. Among the Protestants families of six children are slightly over half as frequent as families with but one child. whereas among the Catholics they are more numerous than the one-child families.

Among the foreign born parents the most frequent family is the one with three children. One-child families are relatively much less frequent than among native born parents. Families of six and even seven children are more numerous than the one-child families among the foreign born, and there are relatively many more families with five to fifteen children, although families with both parents native born are over four times as numerous as the families of foreign born parents. There are actually more families among the latter having over eleven children, and in each group there is the same number of families with eleven children, viz: seventeen. The curve indicating the variations in the size of families shows a markedly greater spread for the Catholic and foreign born parents than for the Protestant and native born parents.

The spread of the curve of variability is considerably greater for the families of grandparents of the students than for the parents. The modal number in the grandparents' families is shifted to four. Small families of one or two children are relatively less numerous, and the one-child families are outnumbered by families of six, seven and eight. Very large families of ten to sixteen children are much more common. The decline in the birth rate between the period represented by the grandparents and the parents of our students has resulted in the loss of a little over 1.5 children per family.

Is the Group Maintaining Itself?

Is the fertility of the group sufficient to perpetuate the stock without loss? Were the true fecundity of the kind of people who recruit our college population correctly represented by our figures, it would probably be sufficient to maintain the stock. But on this point we cannot speak with assurance. Three and a half children per family with the death-rate which at present obtains in the class in question would probably be sufficient to cause a small increase in numbers did nearly all the individuals marry. But we have no accurate knowledge of what proportion of our somewhat indefinite class fails to marry. Our census gives the

proportion of people of different ages who are married, widowed or divorced, but this does not tell how many of a family who reach the marriageable age actually marry. Knowing the average number who live to maturity and the proportion of the latter who marry and found more families, one can estimate the number of children per family required to perpetuate a stock. To obtain data on the proportion of people who marry some time during their lives one must have recourse to genealogies and special investigations of limited groups. It has been found that over ninety-seven per cent of Methodist ministers marry, over ninety per cent of American men of science marry, about seventy-five per cent of Harvard graduates marry and a little over fifty per cent of the graduates of most women's colleges marry. The class that sends students to college contains several components of a low marriage rate. In our group of parents over seventeen per cent of the mothers were college women, mostly graduates, and over thirty per cent of the fathers were college men. Among the people of a degree of culture and status comparable with the parents of our college youth the proportion who remain unmarried is probably somewhat between ten and twenty-five per cent. Our estimate of this confessedly indefinite class cannot be at all precise because the class includes members whose proneness to marry varies from that of Methodist clergymen to that of the graduates of Vassar. It is, therefore, a matter of doubt if with our present death rate, an average of 3.5 children would suffice to reproduce the general class of fairly well educated people who supply our college students.

Three and a half children per family, however, is too high a figure for this class, because our method of selection tends to put a premium on large families. The families of college graduates so far as recent studies indicate have an average of not more than 2.25 children. Our figures give slightly over 3.25 children in families in which one or more parents attended college. As there are some included who did not complete their college course the number of children may be raised slightly by this circumstance, but not to a great extent. The difference is mainly due to the method of selection. The facts point to the conclusion that the method of selection is far from compensated for by the economic and other factors previously mentioned which tend to favor the selection of smaller families.

It makes a good deal of difference, as we have previously stated, whether we estimate the size of families by actual enumeration of the population or by starting with a selected group and then estimating the size of the family from which the members come. The latter method gives a figure larger than the former because, other things equal, people come from families of more than the average size. Taking, for instance, the distribution of the families of various sizes given in Crum's studies on American genealogy[1] and confining our addition to the completed families of the period between 1870 and 1879, we have an average number of 2.77 children per family. If now we consider that we have the same children and then inquire what is the actual size of the family from which they probably come we would obtain a figure of 4.11 per family. The average child comes from a family of more than the average size. Taking again Popenoe's study of the sizes of families of Methodist clergymen[1], we find that if we estimate the size of the families from which the members came, the average would be 4.7, whereas the average size of these clergymen's families is actually only 3.12. Since our students come from families with an average number of 3.66 children, the true average size of the family in the group from which they are drawn, can not in all probability be more than three.

[1] *Publ. Am. Statist. Assoc.* 14:215-222. 1914.
[1] *Journal of Heredity,* 8:455-459. 1917.

Most of the studies of completed families of old American stock in the northern states agree in showing that the average number of children per family is about 2.7. I have made a separate tabulation of the size of families of students of whom both parents and all four grandparents were born in the United States. The parents were found to have an average family of 3.43 children. The mothers came from families averaging 5.08, while the average of the families to which the father belonged was 5.15. When we consider that 3.43 represents an exaggerated figure, it is very probable that the native American stock of the general status represented by the parents of our students is at present failing to reproduce itself

TABLE I—Sizes of the Families of the Grandparents of College Students

	FATHER'S PARENTS			MOTHER'S PARENTS		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	2634	515	5.11	2745	506	5.42
1921	4285	741	5.78	4082	747	5.46
1922	4521	857	5.28	4466	855	5.22
1923	5435	1076	5.05	5157	1076	4.80
1924	4340	849	5.11	4422	851	5.19
Totals	21215	4038	5.25	20872	4035	5.16

Average family of all grandparents 5.21.

TABLE II—The Sizes of the Families of College Students Grouped According to the Birth Place of the Parents

	FATHER NATIVE BORN MOTHER NATIVE BORN			FATHER FOREIGN BORN MOTHER FOREIGN BORN		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	1385	393	3.52	297	69	4.70
1921	1809	541	3.34	700	145	4.83
1922	2183	669	3.26	725	163	4.44
1923	2553	753	3.38	888	184	4.82
1924	2231	686	3.25	805	181	4.45
Totals	10161	3042	3.34	3415	742	4.60

	FATHER NATIVE BORN MOTHER FOREIGN BORN			FATHER FOREIGN BORN MOTHER NATIVE BORN		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	123	30	4.10	272	68	4.00
1921	102	30	3.40	354	96	3.68
1922	140	39	3.59	328	95	3.45
1923	177	47	3.77	341	95	3.59
1924	115	35	3.29	386	112	3.45
Totals	657	181	3.63	1781	466	3.82

General average for all students 3.66.

TABLE III—The Sizes of the Families of College Students Grouped According to the Religion of the Parents

FATHER PROTESTANT MOTHER PROTESTANT				FATHER CATHOLIC MOTHER CATHOLIC		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	1648	439	3.79	246	61	4.03
1921	2377	647	3.67	394	84	4.69
1922	2589	767	3.37	377	80	4.71
1923	3174	896	3.54	404	93	4.34
1924	2762	825	3.34	473	109	4.34
Totals	12550	3574	3.48	1894	427	4.44

FATHER PROTESTANT MOTHER CATHOLIC				FATHER CATHOLIC MOTHER PROTESTANT		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	49	13	3.77	37	12	3.08
1921	48	15	3.20	51	14	2.65
1922	67	23	2.91	42	15	2.80
1923	80	27	2.96	59	19	3.10
1924	44	13	3.39	45	18	2.50
Totals	288	91	3.16	234	78	3.00

TABLE IV—The Sizes of the Families of College Students Grouped According to the Education of the Parents

FATHER-COMMON SCHOOL MOTHER-COMMON SCHOOL				FATHER-COMMON SCHOOL MOTHER HIGH-SCHOOL		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	528	127	4.16	189	52	3.63
1921	852	196	4.35	296	75	3.94
1922	826	209	3.95	360	111	3.24
1923	1214	279	4.35	589	152	3.85
1924	1170	290	4.03	347	110	3.16
Totals	4590	1101	4.17	1777	500	3.55

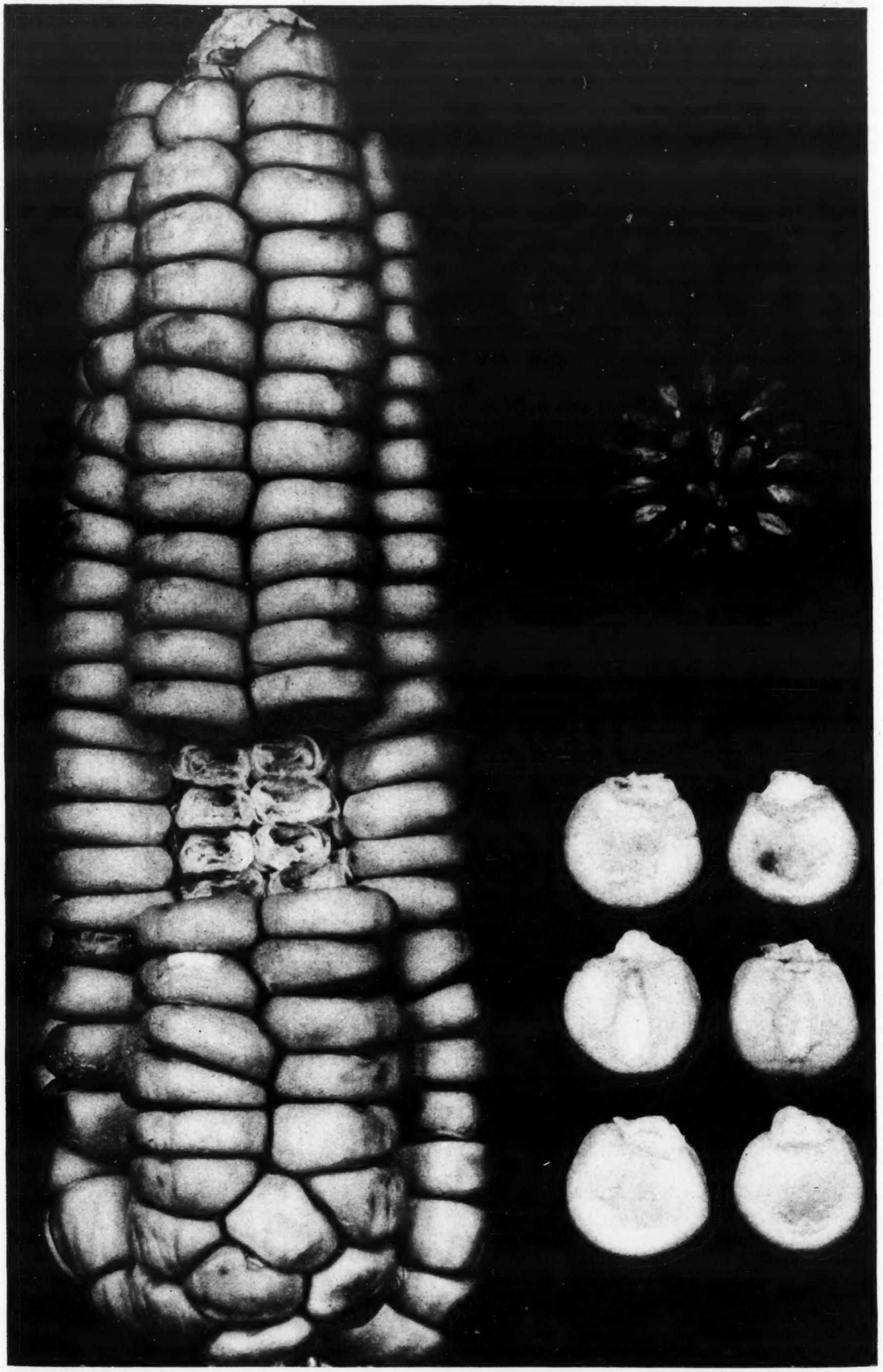
FATHER-COMMON SCHOOL MOTHER-COLLEGE				FATHER-HIGH SCHOOL MOTHER-COMMON SCHOOL		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	33	8	4.12	173	42	4.12
1921	46	11	4.18	212	55	3.85
1922	71	23	3.09	275	71	3.86
1923	84	24	3.08	235	58	4.05
1924	95	32	2.97	295	82	3.60
Totals	329	98	3.35	1190	308	3.89

TABLE IV—Continued

FATHER-HIGH SCHOOL MOTHER-HIGH SCHOOL				FATHER-HIGH SCHOOL MOTHER-COLLEGE		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	392	110	3.54	95	29	3.27
1921	569	170	3.35	80	30	2.67
1922	707	211	3.35	168	51	3.29
1923	703	208	3.39	148	42	3.52
1924	580	173	3.35	96	35	2.74
Totals	2951	872	3.38	587	187	3.14

FATHER-COLLEGE MOTHER-COMMON SCHOOL				FATHER-COLLEGE MOTHER-HIGH SCHOOL		
Date	Number of Children	Number of Families	Aver. per Family	Number of Children	Number of Families	Aver. per Family
1920	84	23	3.65	383	101	3.79
1921	108	31	3.48	510	150	3.40
1922	108	33	3.27	467	144	3.24
1923	100	30	3.66	523	167	3.13
1924	162	46	3.52	421	139	3.03
Totals	562	163	3.44	2304	710	3.24

FATHER-COLLEGE MOTHER-COLLEGE			
Date	Number of Children	Number of Families	Aver. per Family
1920	253	70	3.61
1921	270	86	3.14
1922	327	100	3.27
1923	345	113	3.05
1924	341	104	3.28
Totals	1536	473	3.10



LARGEST AND SMALLEST GRAINS OF MAIZE

Figure 1. Cuzco corn from Peru undoubtedly produces the largest grains of any variety of maize, and Rice Pop probably the smallest. In internal structure these two types differ almost as much as in size. Cuzco is one of the so-called "flour corns," the grains being made up entirely of soft starch, so that in texture they resemble a piece of chalk. The grains of Rice Pop, on the other hand, contain only hard starch, which is almost like horn in consistency. Crosses between these two divergent types are perfectly fertile, and produce grains resembling both flint and dent corn.

THE ORIGIN OF FLINT AND DENT CORN

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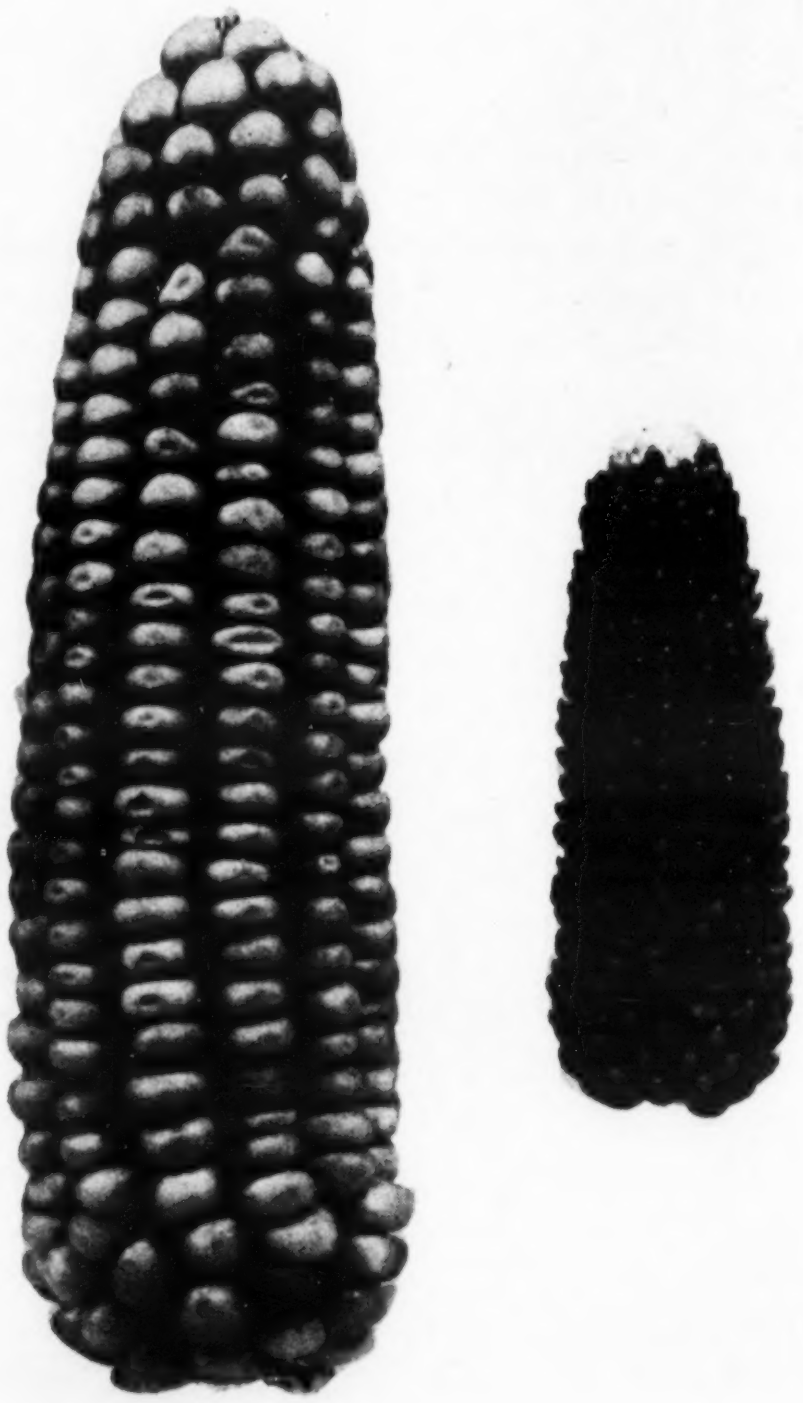
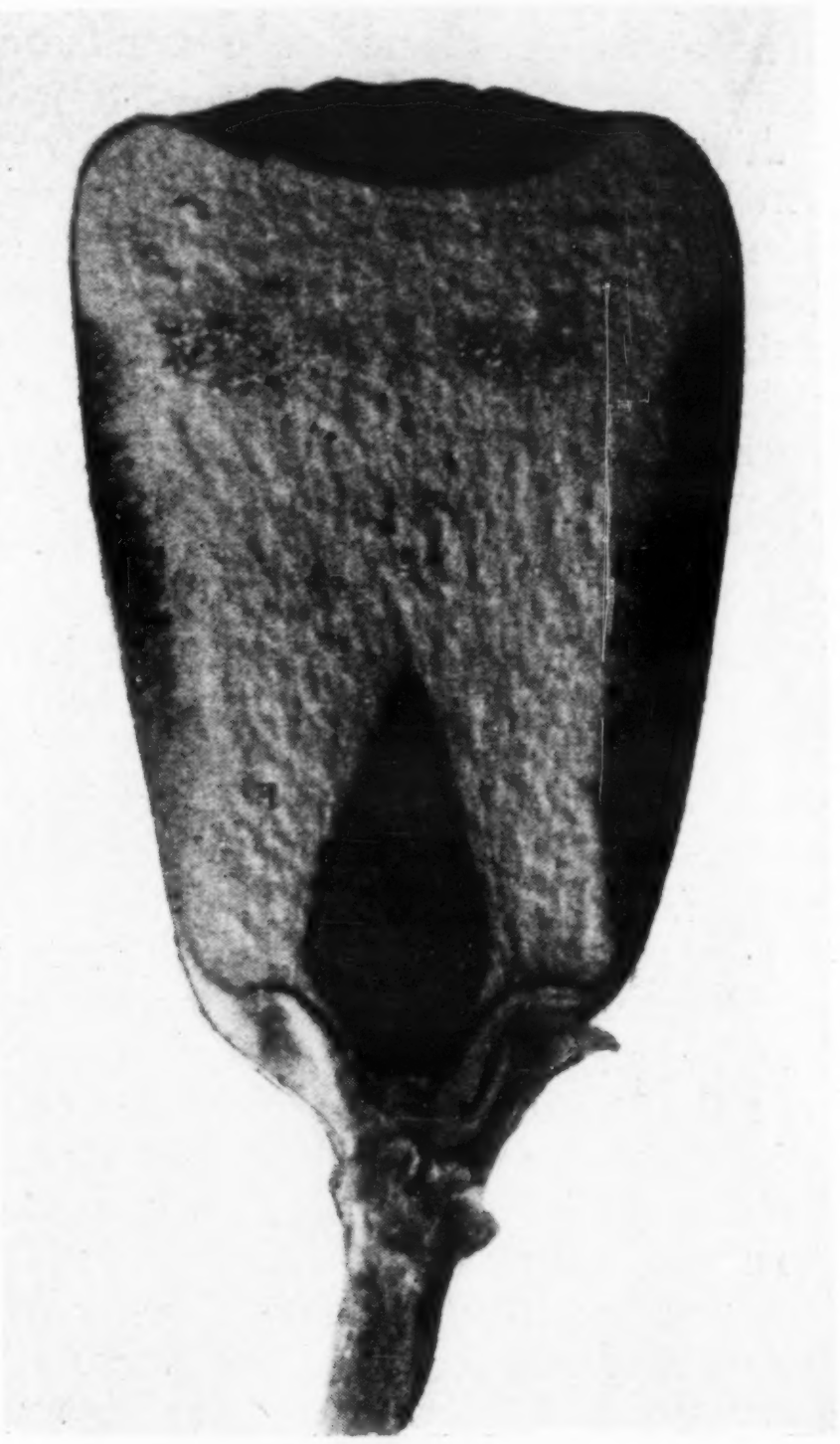


EARS OF RICE POP AND CUZCO HYBRID

Figure 2. The tiny ear on the right is a full-sized ear of California Rice Pop corn The other is a self fertilized ear from a first generation hybrid of Rice Pop with Cuzco. The grains of the hybrid ear are intermediate in size between those of the parental types and contain varying amounts and arrangements of hard and soft starch. Some of the grains resemble dent corn in structure and others contain more hard starch and resemble the flint varieties.



CROSS SECTION OF GRAIN OF DENT CORN

Figure 3. The core of soft starch appears white in the photograph, in contrast to the surrounding layer of hard starch, which is dark. The "dent" is caused by the greater shrinkage of the soft starch when it dries. Grains of flint corn also contain both kinds of starch, but the layer of hard starch extends entirely over the tip of the grain, making a rigid outer shell that does not shrink.

THE TWO most commonly grown types of Indian corn are the flints and the dents. Both types vary widely in size and form of ears and in the plants which produce these, but each is characterized by having both soft and hard starch stored as food in the seed. Soft or floury starch has plump, smooth starch grains that are easily separated. Areas of soft starch are opaque and when the seeds are colored yellow the soft starch is

very pale or colorless. In the hard or corneous starch the grains are cemented together in a dense brittle mass that is more or less translucent and is highly colored by the yellow pigment occurring in yellow varieties. In flint corn the soft starch is restricted to a small area around the embryo and is covered with a thick layer of hard starch. Dent corn has more of the soft starch which extends as a central core to the tip of the seed, the hard starch being placed at the sides. The greater shrinking of this soft starch in the center gives the characteristic indentation of dent corn (See Figure 3).

In the small seeded pop corns there is a type in which no soft starch occurs. At the other end of the series we have the soft flour corn of the Indians which has seeds with no hard starch. It is rather easy to surmise that the intermediate dent and flint types have originated from the crossing of these two distinct types of endosperm. There is considerable evidence to support the view that modern dent corn has resulted from the mixing of flint and flour corn as brought out by Wallace and Bressman in their recent book, *Corn and Corn Growing*.*

A number of quotations from early writers indicate that a late maturing floury type of corn known as "gourd seed" was commonly grown along with the early northern flint varieties in and about Virginia in the early part of the past century, where both the late and early varieties could be grown successfully. Presumably the mixing of these types produced dents of a primitive form and from these the modern types of dent corn may easily have developed.

Crossing Cuzco and Rice Pop Corn

Both the dent and flint type of kernel can be produced by crossing a completely corneous with a floury variety as shown in the accompanying illustrations. A variety of pop corn called California Rice Pop has the smallest seeds known to the writer to occur in maize. As the most extreme contrast to this stands the large seeded flour corn from the Andes, known as Cuzco. The Rice Pop seeds are from two to three millimeters broad and five to seven millimeters long, the size of a grain of rice, and have no soft starch. The Cuzco has probably the largest seeds of any variety of corn known. They range in size from fifteen to twenty millimeters in breadth and twenty to twenty-five millimeters in length, about the size of a large marble, only flattened. They have no hard starch and in texture are much like pieces of chalk. The larger seeds have about sixty-five times the volume of the smaller seeds. The difference in size of seed is perhaps the greatest that exists in any single plant species.

These two extreme types were crossed both ways. The Cuzco plants were started early in the greenhouse and set in the field at the usual planting time. The plants grew very large, and late in the season produced pollen and one plant ripened seeds which had been fertilized by Rice Pop pollen. These were rather poorly developed and were considerably smaller than typical seeds of this variety grown in Peru due to the shortened season and growing conditions to which it was not adapted. The pop corn seeds from Cuzco pollen developed normally and did not differ from the variety type.

The hybrid plants were started early in the greenhouse and grew vigorously when set in the field. They flowered in good season and ears developed abundantly. These were larger than either parent type, while the seeds were intermediate in size. Several ears were self-pollinated and set full of seeds showing no indications of sterility. One of them is shown in the accompanying illustration in comparison with a typical ear of Rice Pop and an ear of Cuzco grown in Peru (Figures 1 and 2).

Cuzco seeds show a slight tendency to indent due perhaps to their very large size, since smaller seeded floury varieties

*Wallace Publishing Co., Des Moines, Iowa.

are perfectly smooth. Many of the seeds on the hybrid ear are well indented. All of the seeds have varying amounts of soft and hard starch and seeds of dent type and flint type can be found on all of the ears. There seems to be no doubt but that fairly good flint and dent types could be separated from this cross.

The Origin of Maize

This direct evidence does not settle the question as to the actual course of events in the production of corn types. In advancing the view that dent and flint corn has originated from the crossing of hard and soft starch types, we cannot be at all certain that the cart has been hitched up the right way. We might as easily assume that flour and pop corn are extreme variations from an intermediate type of somewhat the same nature as our dent and flint varieties. In fact, if Collins' theory as to the hybrid origin of maize is correct, this would be the more logical assumption. Collins gives many cogent arguments in support of a mixed ancestry for maize. One of the assumed parents is teosinte or a closely related ancestral type. The other is a wholly unknown member of a different tribe of grasses, the Andropogoneae, to which the sorghums belong. Many of the sorghums have only soft starch in their seeds. In contrast to this the Poaceae as represented by teosinte (Euchlaena) and gama grass (Tripsacum) have hard corneous seeds with little or no soft starch. On the other hand, some of the small seeded sorghums like Johnson grass have hard corneous grains and broom corn has seeds that will pop like pop corn. The character of the starch stored in the seeds is variable in grasses and the fact that both soft and hard starch occur together in maize is not necessarily attributed to a hybrid origin. But such a beginning accounted for on other grounds might easily bring about an endosperm having varying proportions of the different kinds of starch material. From this all of the known types of normal endosperm could have been derived. Whether the original intermediate condition persisted and finally gave rise to our present day forms of flint and dent corn or whether these have been created anew from the crossing of extreme variations, such as pop and flour corn is largely speculation. The evidence here presented shows that recombination by crossing is a very easy method of bringing about variation in corn from which new forms may be developed.

BIRTH CONTROL

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ASSEMBLYMAN John Boyle, Jr., of Huntington, Long Island, at the last session of the New York State Legislature, introduced a measure proposed by the American Birth Control League, Inc., amending Section 1145 of the New York State Penal Code, to permit all the physicians of the State to give out information to married persons as to methods of birth control. The measure was introduced so late in the session that it was not reported by any committee. It will be introduced again this year. The bill has the merit of making it legal, if it passes, for an individual to move up from barbarism and to take the extremely important business of having and raising children out of the realm of superstition and accident. It is desirable, and commendable as a vast improvement over our present regulations; and it disturbs present adjustments very little. Probably the voters would not accept any more extreme change. But though legislation may be hobbled by what the public

will sanction, some of us in our thinking are ready to go a step farther.

With the passage of the proposed amendment, probably not very widely heralded at best, there will be many who glance at the newspaper articles and forget them, or fail altogether to notice what has been done, and so fail to realize that the means of preventing poverty and in some cases various other ills, are within their grasp.

This failure to sense and make use of available information is illustrated by the experience of our ex-soldiers. Probably every man of the four millions in the World War army heard at one time or another of ways to prevent venereal disease, some of which will also prevent conception. Many who scorned illicit sex relations viewed the preventive measures with repulsion and disgust; not understanding that they might have a perfectly honorable application.

Both the honorable and the licentious ex-soldiers in many cases marry and have children they cannot support or the unregulated bearing of which endangers the health of their wives, without knowing that already in their possession they have knowledge which could save much suffering.

Similarly, under an amended state law which puts within reach of anybody who marries, information which would be of great importance to him, it seems very likely that there are many who will overlook their opportunity—as many in the olden times of tuition education ignored their possibilities for learning. From the standpoint of eugenics these who are slow to adjust themselves to their environment are likely to be comparatively undesirable and for society's benefit ought to have few children. Besides that, there will be some difficulty in rural districts in obtaining the legalized instruction.

And so, after the present measure passes, or if it fails, it may be well to bring up a later bill providing for distribution of the necessary information on a different basis from that which the amendment to Section 1145 proposes. For some years there has been occasional expression of the idea that the duty of officiating at the ceremony whereby the marriage contract becomes legal, should be the duty of physicians rather than of the clergy; and there can be little valid ground for objection for at least the requirement of a certificate showing physical fitness, sufficient, let us say, for entrance into the army. However, from the time when church and state were united the state has recognized the priests and ministers as its agents or notaries in legalizing the marriage contract and it would be futile to offer now any plan for change of agents.

The marrying function has remained wholly voluntary and there have been no assigned duties. The state has merely recognized the act as putting the individuals in a new legal status. It has, however, established limits to the effectiveness of the ceremony. No persons shall marry who are below a certain age or are imbeciles, and a supposed marriage in violation of such provisions may be set aside.

It would seem reasonable for another qualification to be made—namely, that no person may be married who has not a clear understanding of the physiology of conception and childbirth and a knowledge of safe and practical contraceptive methods. The duty of informing on this subject all persons whom they marry might well be considered as a duty of the minister or priest. On whom than the clergyman would the duty better rest, of imparting knowledge of so delicate a nature? In order that there might be required some minimum of knowledge, each person contemplating marriage should be given a written examination by the clergyman, and the papers forwarded to a state department. Perhaps also it would not be too much to expect the clergy to supply data which could be statistically compiled, such as earnings and expected earnings of each couple married.

The adoption of some such plan seems to be the next step in a rational treatment of the problem of marriage in its social bearing.

VARIATION AMONG THE SPORELINGS OF A FERTILE SPORT OF THE BOSTON FERN

II. The Second Generation Sporeling Cultures of Fertilis Types

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(*Continued from September Number*)

AMONG the forty-one distinct first generation sporeling types of *fertilis* at least half produced normal sporangia with viable spores. Considering the extensive variation of the *fertilis* series, the potentialities of variation offered by these *fertilis* children presented an extremely interesting problem. Would variation of *fertilis* (the variety of different types already having been described in the preceding article) be repeated indiscriminately in the third generation? Or would the new forms reproduce themselves true to type or with restricted variation? Would progressive variation occur as in the bud sports, among which the more advanced types of leaf division have not been thrown by once pinnate types, but only by varieties of a higher degree of division: thus the three, four, and five pinnate varieties among the bud sports have only developed as progressive saltations from the division forms next simpler. With such questions in mind, the first cultures of sporelings to be raised were selected from the three grades of division, once, twice and thrice pinnate.

The problem of raising these ferns from spores is simple culturally, but complicated by the limitations imposed by the necessity of greenhouse space. The spores germinate readily, and for about eight months are provided for in the original spore pan, but with the arrival of the time for transplanting, a rapid expansion in space is necessary. If ten per cent of every culture—it was twenty per cent in the original *fertilis* crop—should represent variant forms which deserve further extended experimental culture, the complications involved in supplying the space are obvious. For comparative culture, all plants must be given equally good conditions, lest deductions as to differences be based on the results of modifications due to varying environment. The plants should furthermore receive the test provided by several months of growth in different conditions to allow for the fullest possible development of their distinctive features. As more and more types are raised, with the consequent addition of numerous forms requiring extended observation, the problem is seen to be one of pyramiding space requirements. Consider the possibilities involved with the extension of spore cultures to the next generation, of which one sowing is well under way at present. Probably a location in Florida or in the tropics, where outdoor culture might be used throughout the year would be the simplest solution of the space requirements. The best adaptation that can be made in the North is to sow the spores about August so that the young plants may be ready for setting out under lath shade for several months in the open air the following year. The writer will be glad to send specimen plants of selected fertile, sporeling types to other institutions interested to aid in completing the cultures of these secondary and later new forms.

The Sporeling Progeny of No. 307

(*Figure 4*)

The plant designated as No. 307 is a once pinnate form, apparently identical in characters with the ordinary type of *exaltata*. Spores were sown in 1920, producing a crop of one hundred and fifty plants by the summer of 1921. The great majority of these were strictly once pinnate, with thick leaves, indistinguishable from those of No. 317, a Florida collection of *exaltata*, of which a large crop of sporelings was raised at the same time. All these were discarded except for two plants which were saved for samples of the new type.

Among these once pinnate sporelings were found a few plants showing double division, twelve to fifteen in all. As these developed, they proved to comprise three types of twice pinnate leaves: (1) plumy, stably twice pinnate forms, with broad segments (See Nos. 4 and 6, Figure 4), essentially like the original *fertilis* plants; (2) similar twice pinnate forms but with smaller segments (See Nos. 2 and 5, Figure 4); and (3) once pinnate, pinnatifid forms, in which the pinnae are usually merely deeply crenate-lobed, though they may sometimes approach a twice pinnate condition on a few pinnae (See Nos. 3 and 7, Figure 4).

The common once pinnate type, characteristic of the ninety per cent of these No. 307 sporelings, is illustrated in Nos. 1 and 8. In the same plate is included an illustration of a leaf of the original No. 307 (No. 9). Note its very close resemblance to the leaf of its sporeling progeny shown in No. 8. No. 10 of Figure 4 shows a twice pinnate leaf of the original *fertilis* type.

The diversity of the division forms among these sporelings of No. 307, the production of twice pinnate plants from a strictly once pinnate form, offers a basis for the comment that the external leaf type may be stable even though the hereditary tendencies are unstable.

The Sporeling Progeny of No. 301

(*Figure 5*)

The sporeling accessioned as No. 301 is a form which attracted attention at an early stage (See Figure 9 in the September issue) as distinctive in its growth and leaf characters. When mature, it forms a bushy, erect clump of leaves (See Figure 14 in September number). The leaves are narrow, with thick, firm petioles, twice pinnate at their best development, intermediate in size, eighteen to twenty inches long.

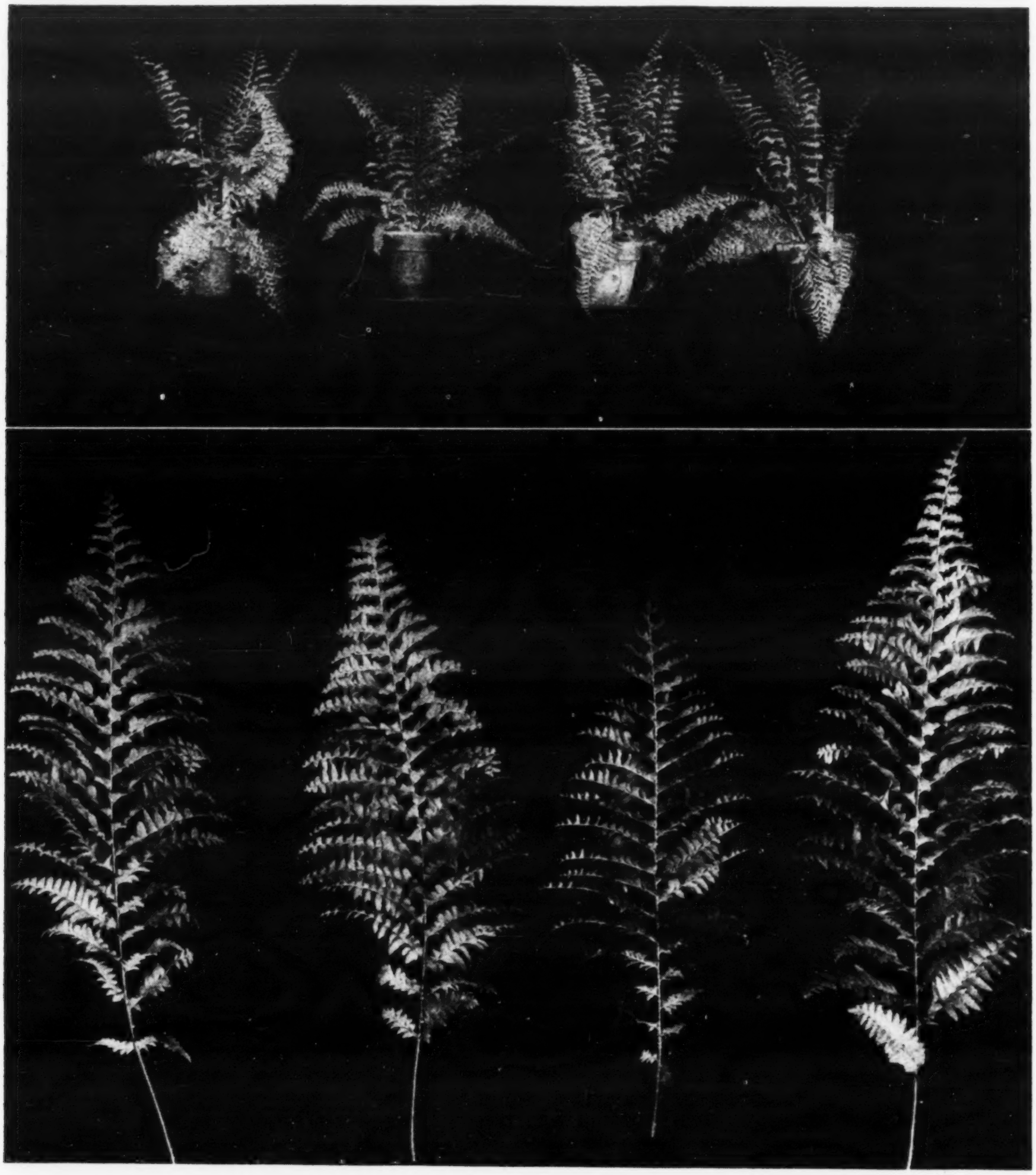
A sowing of spores, made in the summer of 1922, developed its early leaves in April of 1923. From the start, the new plants were remarkable for their uniformity. Double division of the leaves showed early and uniformly. As the plants grew larger their similarity continued. The illustrations in Figure 5 show four plants taken at random when about fourteen months old, and four leaves enlarged, taken from separate plants, but so much alike that they might have come from one. Note the erect habit of the plants. In a total of one hundred and sixty plants in this culture, only two offer any ground for possible separation as different from the mass. One of these shows mostly once pinnate leaves and may represent a vegetative reversion, produced since the formation of that particular plant; the other agrees in habit and degree of division, but the segments are somewhat malformed, perhaps pathological.

The original plant of No. 301 has been lost from the collection at the Botanic Garden owing to accident, so that comparative culture of parent form and progeny cannot be made.* One point of similarity has been noted, besides the erect habit: the original plants occasionally showed one or two leaves per plant infected with the *Glomerella* disease and a similar slight infection has been noted on one leaf of one of these second generation plants. The most interesting point about this culture is the stability mani-

*Since recovered and shows uniformity with its progeny.

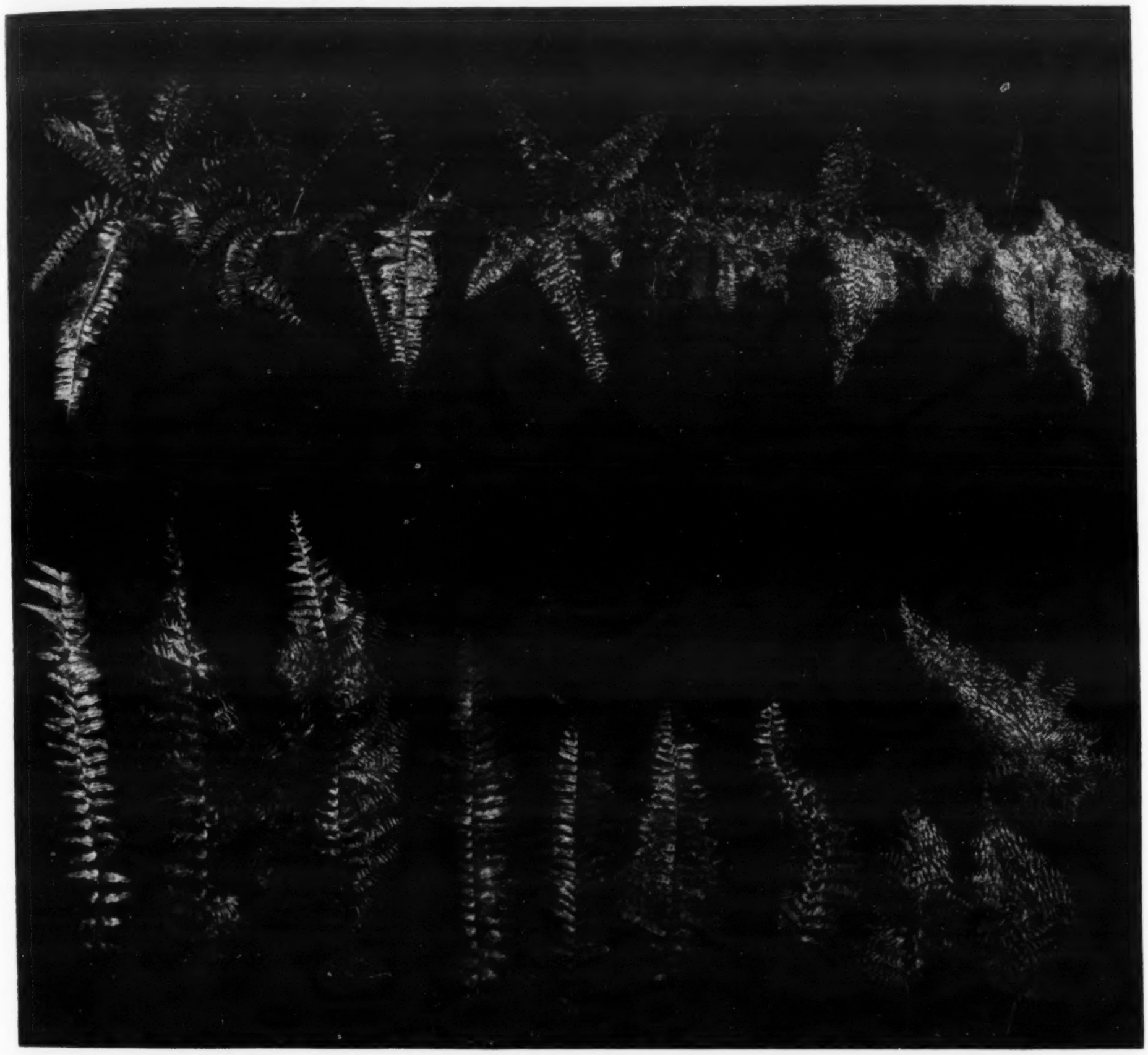
SECOND GENERATION CULTURE OF ONCE PINNATE SPORELING

Figure 4. A leaf of the parent plant, Sporeling 307, is shown at 9, and a leaf of the original *fertilis* at 10. Of the four plants shown in the upper row, the first is a once pinnate form like *exaltata*. (A leaf of this plant is shown at 8.) The second has twice pinnate leaves, one of which is shown at 5, with small segments. The third is an unstable form, in which the great majority of the pinnae are undivided, or merely slightly lobed—a few are twice pinnate with narrow segments (Leaf at 7). The fourth plant is a twice pinnate form like fertilis (Leaf at 6). The variation of the plants in this culture is in striking contrast to the uniformity of the second generation progeny of Sporeling 301 (Figure 5), but all the second generation cultures were less variable than the original *fertilis* cultures.



A UNIFORM SECOND GENERATION CULTURE

Figure 5. In the upper row are shown four plants of the culture of Sporeling 301, and below are the leaves from four other plants. Note the remarkable uniformity, as compared with the other three cultures (Figures 4, 6 and 7). Of 160 plants in this culture only two were noticeably different from the mass.



VARIATION IN LEAVES IN SECOND GENERATION CULTURE

Figure 6. In the upper row are shown seven plants, varying progressively from once pinnate on the left to four times pinnate on the right. In the lower row are shown, on the left three leaves of the parent plant, Sporeling 320, and then in order a leaf from each of the seven plants in the upper row. Sporeling 320 is an unstable form that produces both once pinnate, twice pinnate and thrice pinnate leaves as are shown here.

fested, not only of its original type of leaf division, but also in the uniformity of progeny.

The Sporeling Progeny of No. 320

(*Figure* 6)

This sporeling number was selected for spore culture because it represents the three-pinnate type of leaf division. The original plant accessioned under this number did not at first manifest any difference from the ordinary twice pinnate sporeling form most common in the original 1917 *fertilis* culture. It had not been differentiated in June, 1920, when it was set out of doors with a considerable number of similar plants for a season of open culture. At the end of the summer, in looking over a row supposedly all twice pinnate and of the *fertilis* form, one plant was found to be partly thrice pinnate.

In the years since its discovery, it has continued variable in its leaf division. On a single plant there may at times be found leaves possessing three

grades of division; other plants may be entirely twice pinnate; others entirely thrice pinnate. The latter condition is usually produced under the best cultural conditions. Fertile spores are developed in all three types of leaves (See Figure 6).

Good germination was secured in the summer of 1922, and a crop of three hundred and fifty plants was potted up separately in the spring of 1923. Among this population were found plants showing all degrees of division from once to four times pinnate. The range of variation apparently comprises only differences in division; the plants appear uniform in growth and size, except for the reduction in length among the lace-leaved plants correlated with their greater breadth. The once and twice pinnate plants are already showing signs of fertility but it is probable that the four pinnate types will be sterile. The plants are apparently about evenly divided in number among the various degrees of division.

The plants are not distributed distinctly into classes of once pinnate, twice pinnate, thrice pinnate, etc. forms, but present in their present stage of development all manner of intermediate degrees of division. A set of twenty plants have been set out in a stock bench for vegetative reproduction and observation, arranged in a series of advancing steps in division. Other plants are being maintained in pots, representing similar stages. A similar set of seven plants and leaves from these plants is illustrated in Figure 6. The pinnae are shown further inlarged in Figure 8, Nos. 1-8. The four pinnate forms are fine textured and lacy, and give promise of matching the horticultural lace varieties, such as *Smithi, Goodi,* and *gracillima,* very closely. Some uncertainty exists regarding the forms selected at present as strictly once pinnate. In the early classification of the three hundred and fifty plants of this culture into once pinnate, twice pinnate, etc. forms, a much larger number were considered once pinnate than proved later to continue this character. At the base of the leaves of such plants there may often appear a single segment on one or two pinnae, and such plants have later produced leaves of distinct twice pinnate division.

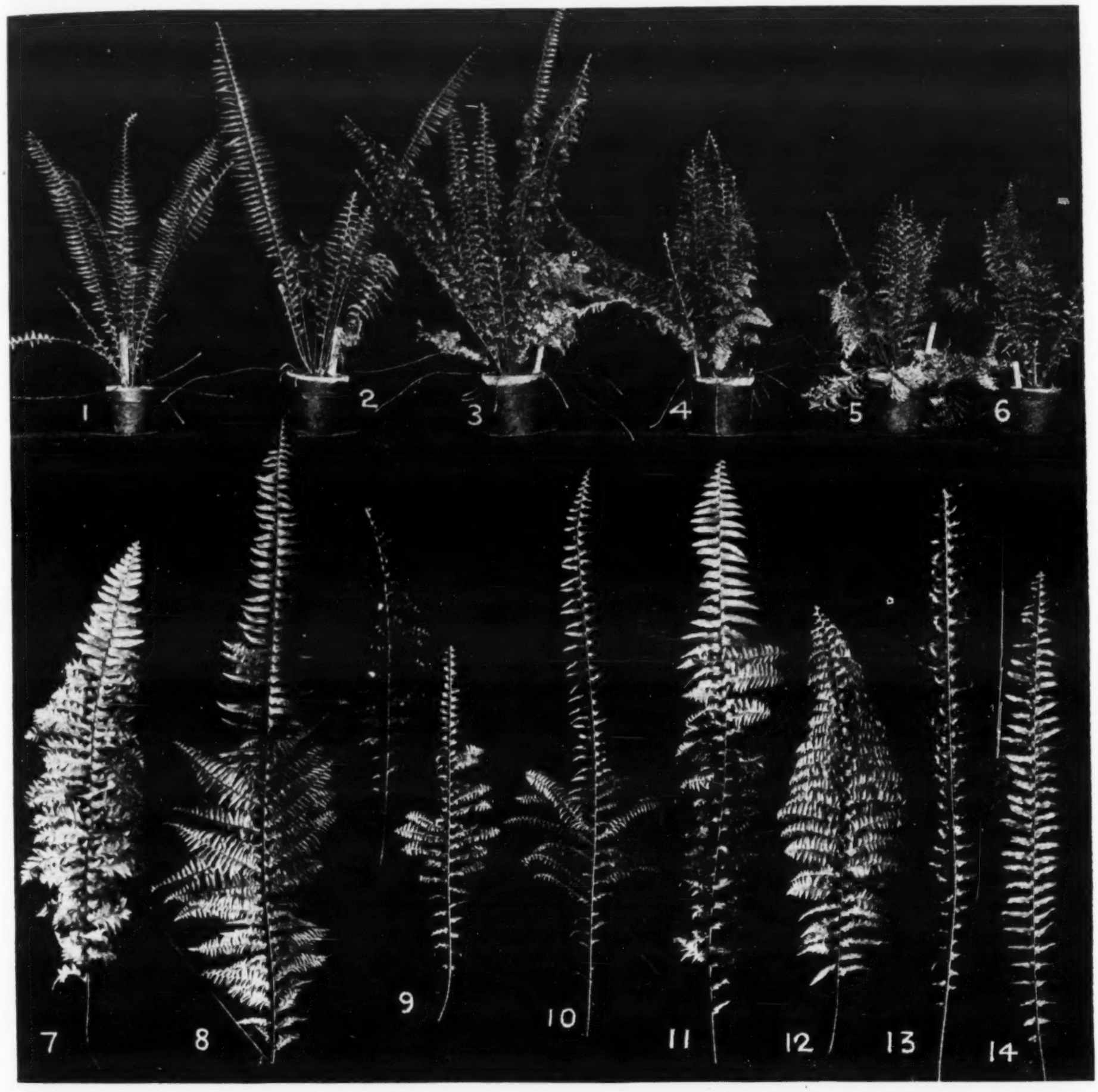
Two points of special interest should be noted with respect to these sporelings of No. 320. First, the fact that they present progressive development in the division line: only in this culture, from a thrice pinnate form, has the advanced, four pinnate division appeared. Second is the fact that despite this extension of the range of division, the progeny of No. 320 as a whole show more limited variation than was found in the culture of *fertilis* itself. This may be noted as true for all four cultures here reported. It will be a matter of special interest to determine by third generation spore cultures of the progeny of No. 320 whether a condition of genetic uniformity is ultimately reached.

The Sporeling Progeny of No. 75-2

(Figure 7)

The *fertilis* sporeling, No. 75-2, has been described as showing continuously unstable division characteristics, its leaves being either once pinnate, twice pinnate, or showing both types of division. It was selected for spore culture particularly to test out in separate sowings the possible variation of strictly once and twice pinnate leaves. Accordingly, two cultures were made of spores from leaves of the desired types, labelled, respectively, "75-2-A-1" for the once pinnate leaf, and "75-2-A-2" for the twice pinnate leaf.

Both cultures developed well, producing several hundred plants apiece. A portion of the spore pan of 75-2-A-2 is shown in Figure 8 in the preceding article (p. 381). It was very early ascertained that the inheritance of the two leaves was the same: the two spore pans appeared identical, and the large crops of young plants could not

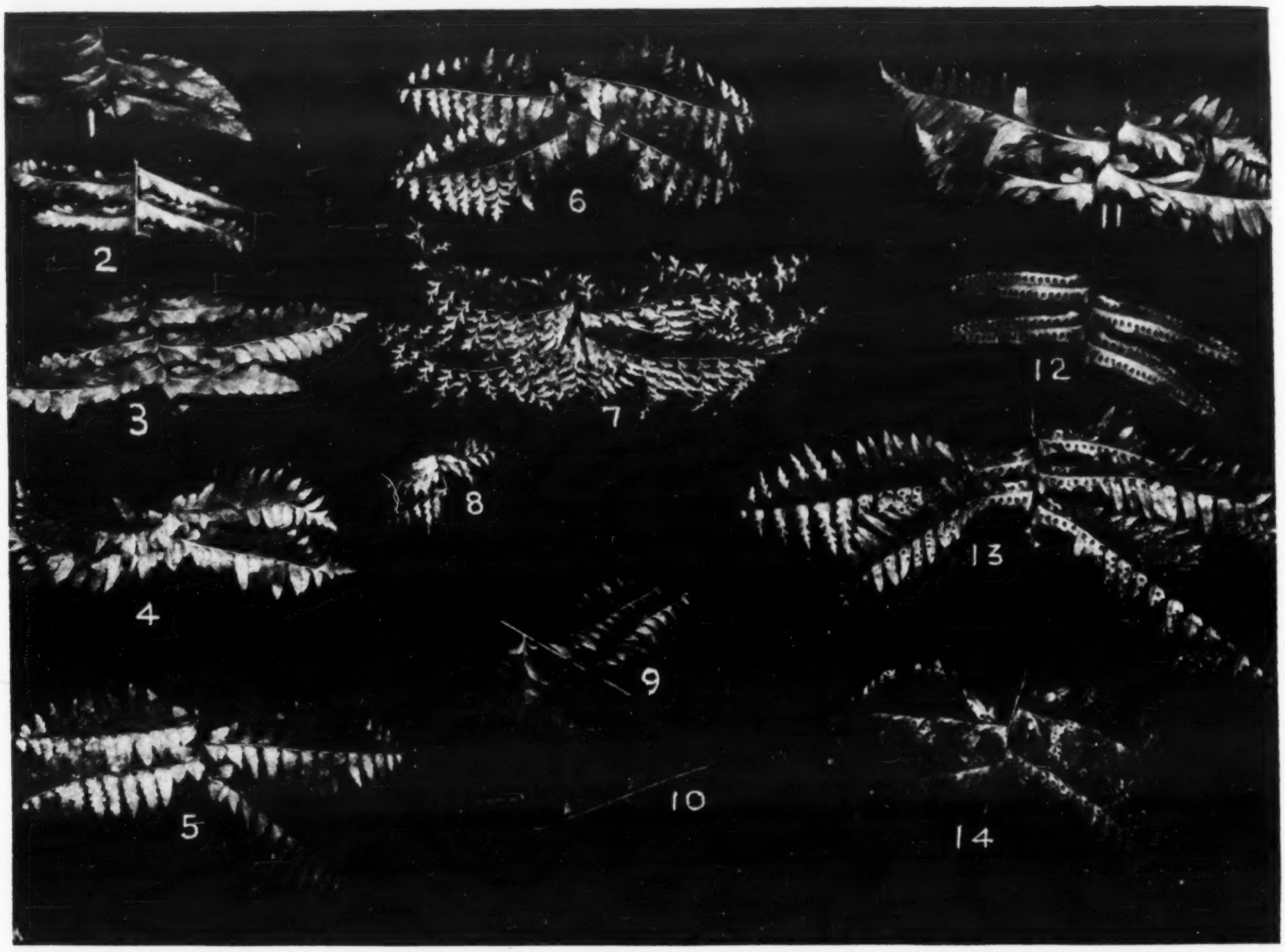


SECOND GENERATION CULTURE FROM TWO LEAVES OF AN UNSTABLE SPORELING

Figure 7. In the upper row are shown six plants grown from a twice pinnate leaf of Sporeling 75-2. Below are leaves from a spore culture of a once pinnate leaf of this form. The two cultures are indistinguishable. Though the parent leaves differed in outward appearance their genetic constitution appears to have been identical.

have been separated if accidental mixture had occurred. In fact, the culture from the twice pinnate leaf developed more once pinnate plants by two or three times than the other. In the five hundred young plants of the 75-2-A-1 culture only five strictly once pinnate plants of the *exaltata* type were found, while twice this number appeared among the two hundred and fifty plants raised from the 75-2-A-2 spores. This difference is not cited as significant except as emphasizing the fact that the external difference between the once and twice pinnate leaves of this progeny does not carry over in inheritance.

The progeny of these two cultures may be grouped together for description into five main types: (1) once pinnate forms like *exaltata*, i. e., with broad segments; (2) once pinnate forms with very narrow segments (See



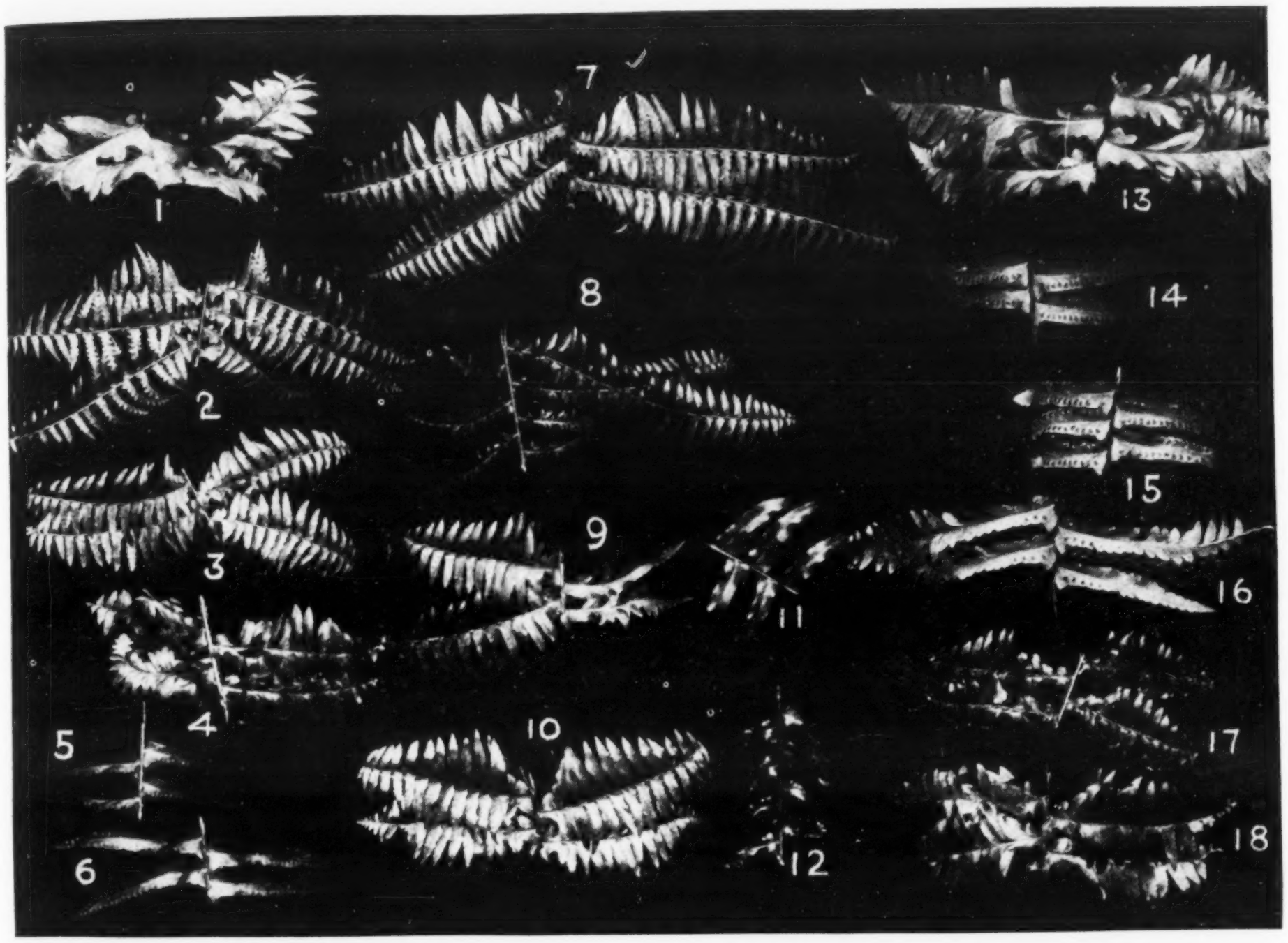
LEAF CHARACTERS OF SECOND GENERATION SPORELINGS

Figure 8. Numbers 1 to 7 reproduce enlarged pieces of the leaves of the plants shown in the upper row in Figure 6. A four times pinnate pinnule of a second generation sporeling of 320 is shown at 8. Pinnae of second generation sporeling 301 are shown at 9 and 10; 9 showing the pinnae, tapered at the tips, and with narrowed bases, and 10 showing basal pinnae. Pinnae of *fertilis* are shown at 11, and the three remaining numbers show pinnae of the first generation sporeling, 320, respectively once pinnate, thrice pinnate, and twice pinnate.

Figure 9, Nos. 1, 13, and 14; and Figure 9, Nos. 5, 6, 11, and 12); (3) twice pinnate forms with full, overlappnig segments, like *fertilis* (See Figure 7, Nos. 7 and 12, and Figure 9, Nos. 1 and 10); (4) twice pinnate forms with narrow, separate segments (See Figure 9, Nos. 3, 7, 8, and 9, and Figure 7, Nos. 8, 9, and 10); and (5) thrice pinnate forms (See Figure 7, No. 5, and Figure 9, No. 2).

The naming of these five classes does not mean that the sporelings could all be readily classified into one or another of the five groups. With this culture as with that of No. 320, there appeared to be no real lines of demarcation between the different degrees of division. Reference to the illustrations in Figures 7 and 9 will demonstrate, even with the few specimens shown, the difficulty of determining the classes of the leaves figured. The great majority of the plants belonged in classes 3 and 4 as described above. The once and thrice pinnate forms were relatively uncommon. Of special interest is the fact, evident in illustrations, of the inheritance of the unstable type of division, even to the mixed condition of almost every single leaf. (See Figure 7, Nos. 8, 9 and 10.)

Variation is thus indicated as restricted in scope for this twice pinnate form as it was in the once pinnate form, No. 307, tested by spore culture.



LEAF CHARACTERS OF TWO SECOND GENERATION SPORELINGS

Figure 9. Pinnae from sporelings of a twice pinnate leaf of 75-2 are shown in Numbers 1 to 6, while 7 to 12 show those from a once pinnate leaf (See Figure 7). Pinnae of *fertilis* are shown at 13, and at 14 pinnae of sporeling 307. The four remaining pinnae (Nos. 15-18) are from the four second generation plants of sporeling 307 shown in Figure 4

The number of once pinnate plants in the combined total of seven hundred and fifty in this culture is relatively smaller than was the number of twice pinnate plants among the sporelings of No. 307. A few forms showing variations in size and in the contour of the pinnae were present (See Figure 7, Nos. 9 and 13, and Figure 9, Nos. 11 and 12) but in general it may be said that the variations of 75-2 sporelings were confined to differences along the line of single division. It seems likely that all the plants retained will prove fertile eventually. A third generation spore culture of a form with narrow segments is advanced enough so that the new sporophytes are just beginning to appear.

Again for these sporelings as for those previously described, it should be noted that (a) new forms, distinct from any known in the original *fertilis* cultures, have appeared; (b) that the scope of the variation is more limited; and (c) that new progressive variation has occurred.

General Consideration and Summary

It is not within the purpose or possibilities of this paper to present any extended explanation and speculation regarding the possible cause of these variations of *Nephrolepis exaltata bostoniensis fertilis*. Only two explanations seem possible to account for their origin. Either they must arise as a result of the splitting of factors in a germ plasm complicated by hybridity, or by reason of the stimulation due to such heterozygosis; or their variability must be explained as due to some in-

herent constitutional tendency for variation, which is merely a phrase to characterize results without in any way illuminating the actual process.

The hypothesis of hybridity has been suggested to explain the behavior of the original Boston fern (Jeffrey at the Toronto meeting of the American Association for the Advancement of Science) in the production of its multiplicity of bud sport types, largely on the basis of its sterility and variability. It is hard, however, to see in this suggestion of a hybrid origin any simplification of the problem. To postulate hybridity seems rather to raise more difficulties than are solved. If *bostoniensis* is a hybrid, what were its parent species? Only two American species of *Nephrolepis* grow normally together in the tropics, *N. exaltata* and *N. biserrata*, a much larger, coarser species. The Boston fern is not intermediate between these two; the bud sports of *bostoniensis* are not in the least suggestive of *biserrata*, certainly not the dwarf, the ruffled, or the divided types. It is unfortunate that *fertilis* did not arise under observation so that its relationship with the Boston fern series might be attested, but it does not suggest *biserrata* in its variation.

Furthermore, the various types of leaf modifications, etc., which have arisen from these two *Nephrolepis* forms, *bostoniensis* and *fertilis*, have appeared in other species and genera of ferns, both under cultivation and in the wild. The development of twice pinnate varieties from once pinnate forms is well known, horticulturally, for many species long cultivated in England, and in the wild, even for so common a type as our native Christmas fern, *Polystichum acrostichoides*. A completely twice pinnate form of this species was shown to the writer a few years ago by Dr. W. R. Maxon in the woods along the Maryland shore of the Potomac, just above Washington. This was transplanted to the Brooklyn Botanic Garden, and a spore culture was started. The new sporophytes developed far enough to show themselves all typically twice pinnate, but conditions of labor shortage during the war most unfortunately led to the loss of both the spore culture and the original plant. However, the writings of the English fern horticulturists such as Lowe, Druery, and others contain numerous instances of similar occurrences in other species and genera.

Whatever the basic, cytological explanation of the variation of these two *Nephrolepis* forms may be, the writer cannot help but feel that their method of origin is to be compared, even homologized, with the origin of new varieties and species in the wild; that these numerous new forms have arisen by virtue of processes which have led in nature to the origin of new fern species. Hybridity may be involved. Chromosome readjustments may be occurring. The salient fact is that a multitude of new forms have arisen and are still appearing which are strongly suggestive of new species as the taxonomist views them.

The behavior of the second generation sports of *fertilis* is significant in many respects; their reduced variability, even stable heredity in one of the four sporelings tested; their progressive variation as compared with the series of forms in the cultures of the original *fertilis*, through which the limits of variation of the *fertilis* sporelings has been exceeded in two of the progenies; the parallelism between the forms of Boston fern bud sports and some of the *fertilis* sporelings, as well as the differences also manifested. The similarities between these two series would seem to indicate a genetic relationship between the parent types, and to supply strongly the identification of *fertilis* as a Boston fern derivative in some degree. All these facts constitute elements of interest and bafflement, and with this point in view, these attempted explanations may be rested. The further attack on the problem through cytological study is obviously suggested but for the writer,

the work incident to raising and maintenance of the numerous forms and their description has already involved more time than has been readily available.

Acknowledgement is due the Brooklyn Botanic Garden for the very satisfactory facilities afforded for the prosecution of the study of these ferns.

1. *Nephrolepis exaltata bostoniensis fertilis* is reported as the only spore fertile variety of the Boston fern, and is assigned as a probable reversion from the horticultural form, *Piersoni*, with which it agrees in vegetative characters.

2. In the first culture of the spores of *fertilis*, in a crop of two hundred sporeling plants, forty-one were selected as well differentiated on the basis of size and form of leaves, division, fertility, habit of growth, disease resistance, and other characters.

3. These varieties present some forms which parallel the variations of the Boston fern, and also other forms distinct from any of the latter.

4. Four of the sporeling progeny of *fertilis* have been raised to a second generation from spores. The resultant plants show decreased variability as compared with the first *fertilis* culture, and progressive variation in the form of increased leaf division.

Making the Most of Heredity

MENTAL TRAINING FOR THE PRE-SCHOOL AGE CHILD, by Lilien J. Martin, Ph. D., and Clare de Gruchy. Pp. 108. San Francisco. Harr Wagner Publishing Co. 1923.

Few parents can fail to benefit by reading this practical little book. It begins with seventeen questions, bearing on the training of the child, which a parent should ask himself. Each of these is then discussed, in the light of theory and application. Case histories are given by way of illustration.

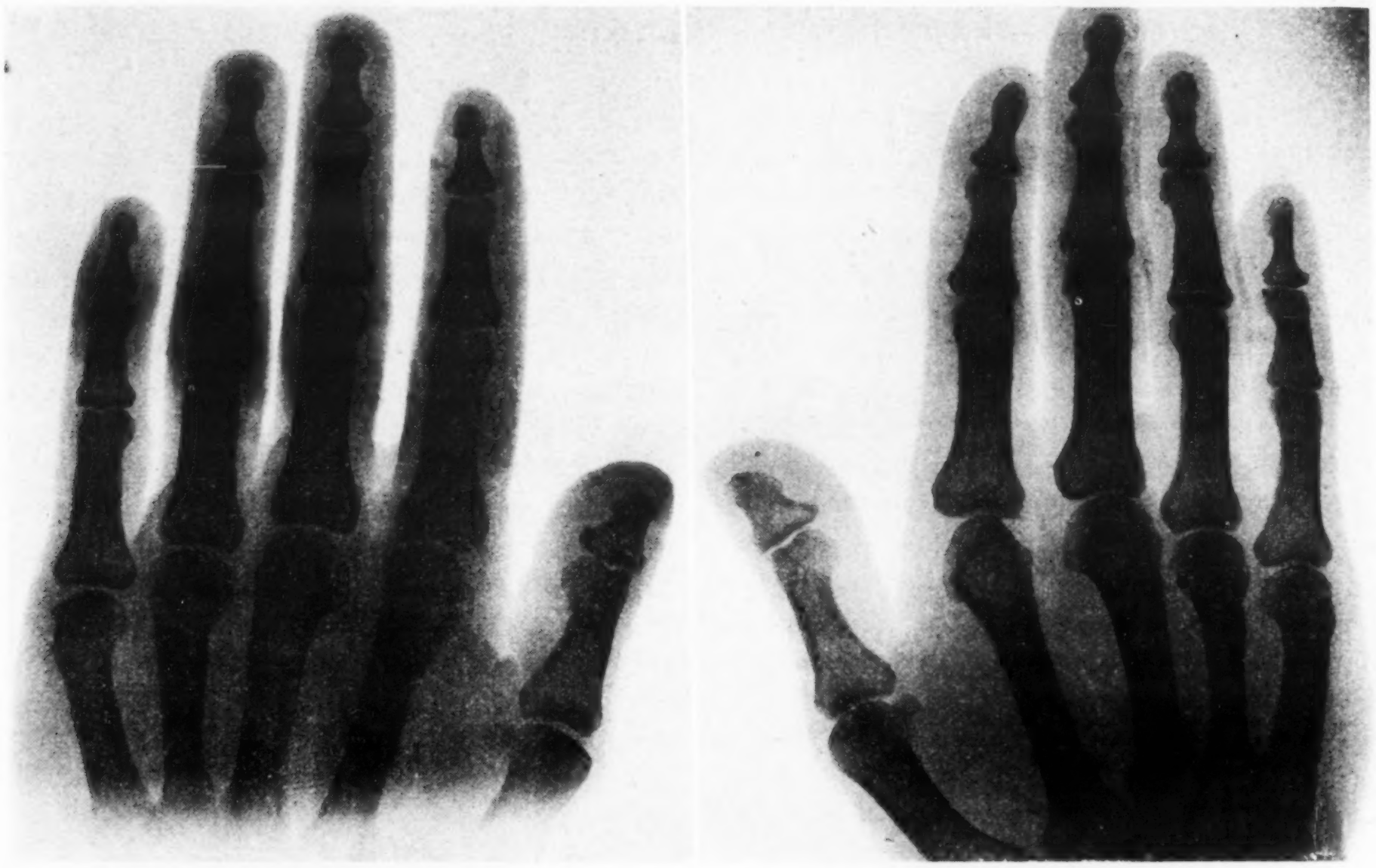
Human heredity is so mixed that no one is free from some inherited handicaps, while most possess at least a few good points for which they can thank their ancestors. "What all parents need for their guidance," the authors assert, "are the results of their child's physical and mental examinations to determine what he has actually inherited in the way of strength or weakness. Then and then only can they set to work intelligently and root out inherited weakness, teach, train and strengthen the child, work with a steady purpose toward a definite goal, developing in the child his highest abilities and rescuing him from pitfalls which, in many cases, were the undoing of his ancestors."

Many volumes have been written on these points, but none simpler and more sensible than this one.

P. P.

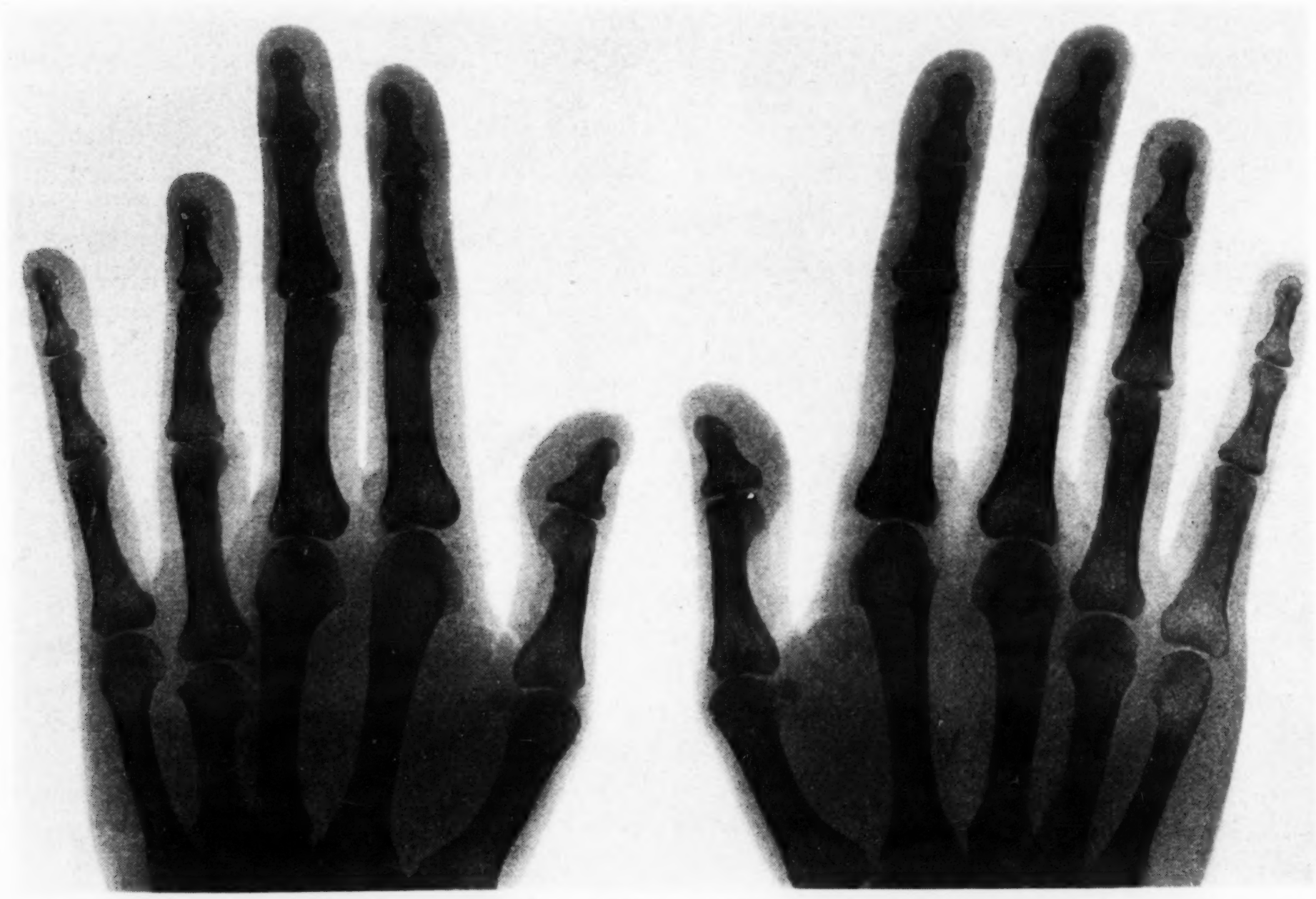
Poker and Eugenics

One thing wrong with our homes is that too many couples think a pair beats a full house.—*Columbia Record.*



SHORT THUMBED HANDS FROM TWO FAMILIES

Figure 10. On the left is shown an X-ray of the hand of a member of the family discussed in Case I (Individual 4 of family II in the fourth generation in the chart, Figure 17). On the right is shown the hand of a man who has no short thumbed relatives for at least two generations.



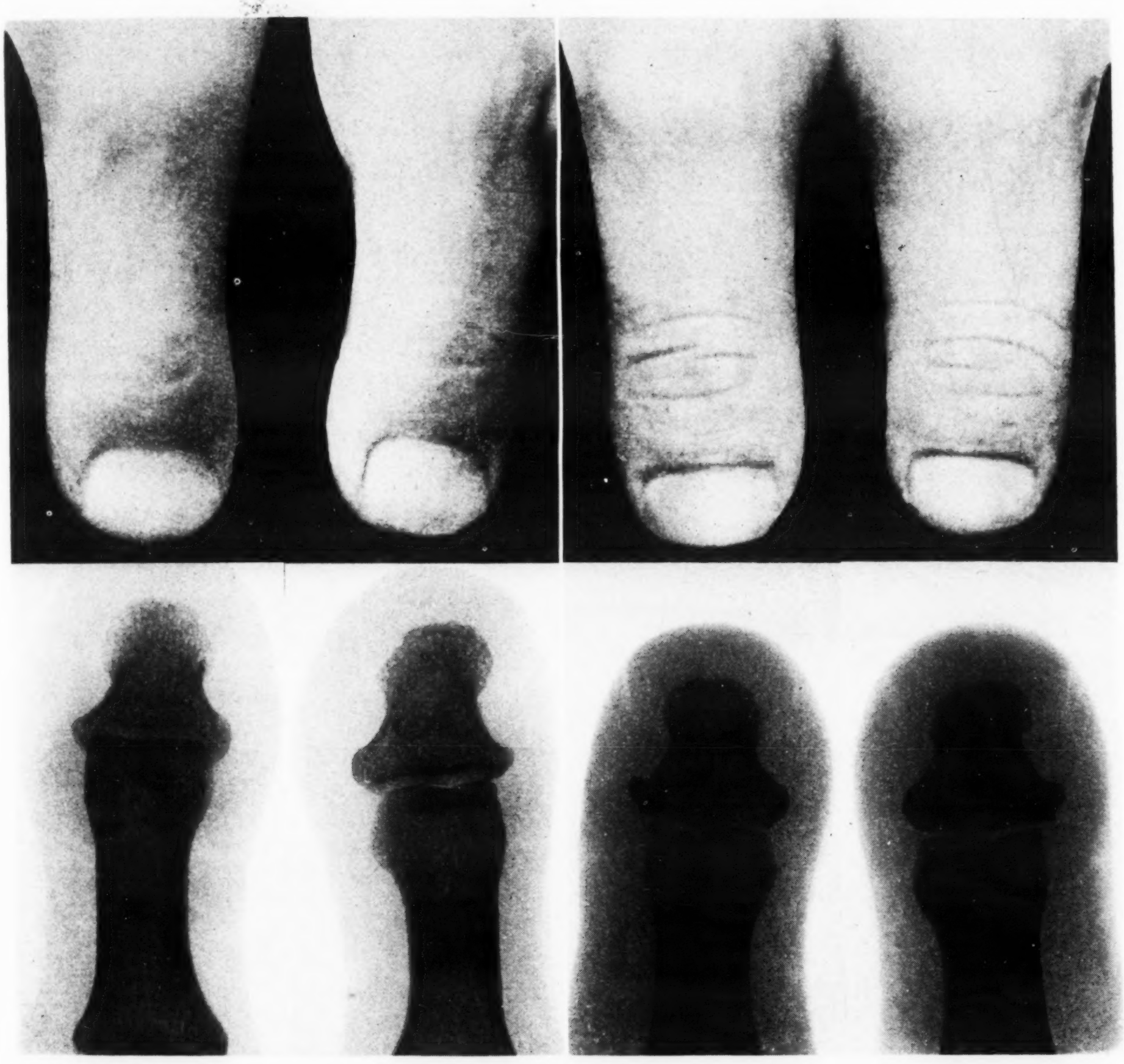
HANDS OF A SHORT THUMBED WOMAN

Figure 11. This is the sister of the man whose hand is shown on the left in Figure 10, and her twin sister also has short thumbs (See Figure 13). Note the short metacarpal bone in the ring finger of the left hand, not found elsewhere in this family.

INHERITED ABNORMALITIES OF THE FINGERS

II. Short Thumbs (Brachymegalodactylism)

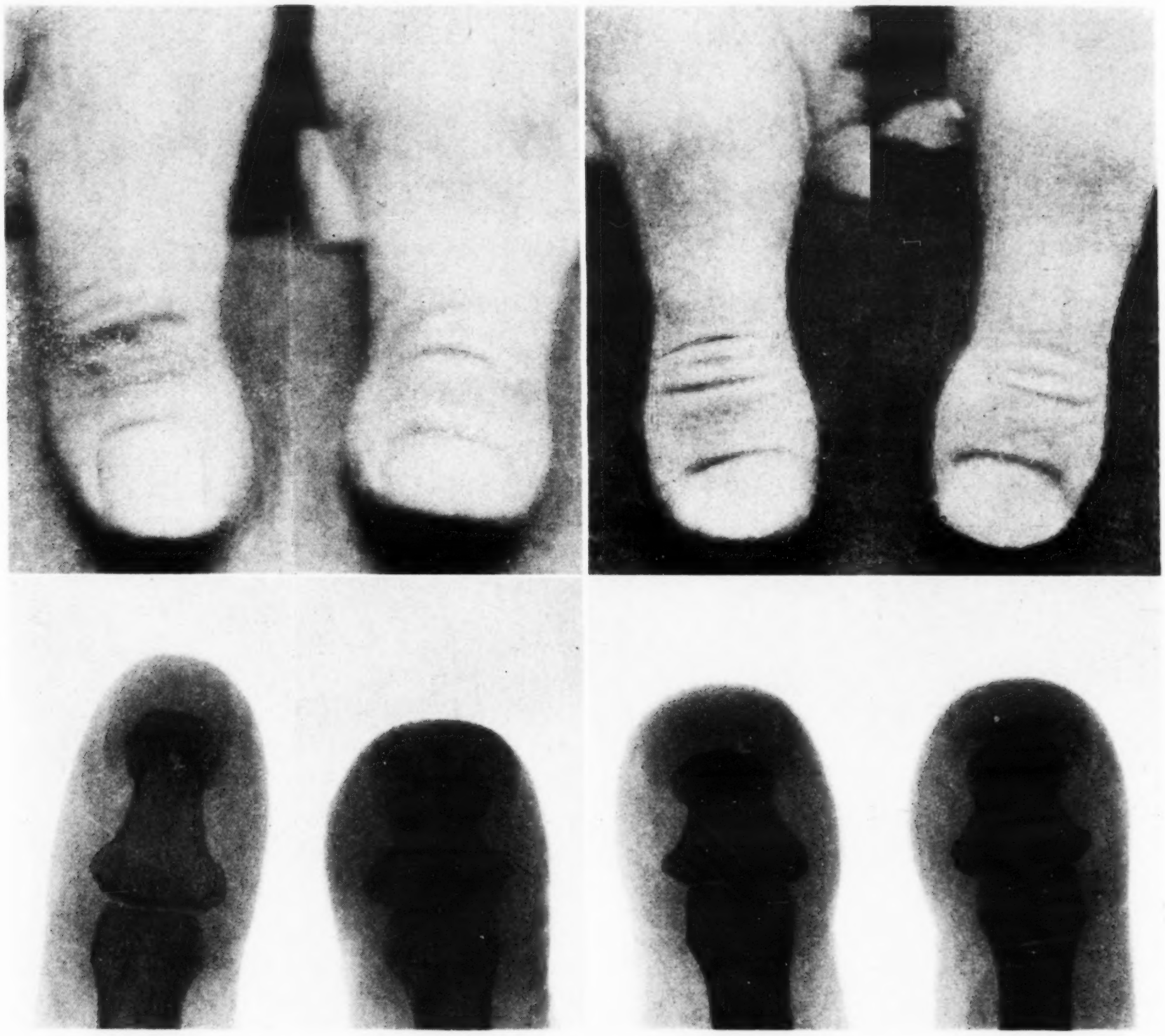
R. A. Hefner
Ohio State University



TWO SETS OF SHORT THUMBS

Figure 12. These are the thumbs of the two individuals, X-ray photographs of whose hands are shown in Figure 10. Short thumbs, or brachymegalodactylism, is a definite Mendelian dominant character that seems to be widely spread and of fairly common occurrence.

A RECENT contribution to the JOURNAL OF HEREDITY[1] calls attention to an hereditary digital variation which has apparently been neglected by students of unit characters in the human race. This variation consists of a minor anomaly showing some of the features of brachydactylism, but, unlike the latter, confined to the thumbs alone. The widespread



TWO GENERATIONS OF SHORT THUMBS

Figure 13. Here are shown photographs of the thumbs of three individuals, a mother and her twin daughters. The thumbs of one daughter are shown in the X-ray photograph and the external appearance of the other twin's thumbs are shown. Note that the mother has only one short thumb. Measurement of these three pairs of hands revealed that in all cases the proximal phalanges of the thumb were the same length (38 millimeters).

prevalence and specific nature of this trait, together with certain interesting aspects associated with its appearance and mode of inheritance, warrant the application of a definite terminology to this condition. The term *brachymegalodactylism* (Gr.; *brachys*, short + *megas dactylos*, thumb) is therefore suggested to supply this need.

Brachymegalodactylism may be defined as the condition of having an abnormally or disproportionally short thumb on one or both hands. The trait is characterized by the appearance of a broad, short, thick thumb, bearing a very short, broad nail. The rest of the hand may show variations but such deviations from the normal are not unit characters in the opinion of the writer. Most prominent among these variations are the hands of individual 2 in family II of the fourth generation in the chart (shown in Figure 16). These hands are long and slender—this being especially true of the fingers, in contrast with the short, thick thumbs. The left hand is further modified by the presence of an abnormally short metacarpel bone articulating with the ring finger, which

is thus greatly depressed but of normal length (see Figures 11 and 12).

No less than four unrelated lines of brachymegalodactylism were investigated in this study and reliable information concerning five more instances in widely separated areas were not followed for want of time and the apparent certainty of a repetition of the facts already observed. Each of the four cases above mentioned will be treated separately.

Case I

(*See Chart, Figure* 16)

This is the most thorough of the studies and covers the hereditary transmission of the trait through five generations in which it appears in one-half of the offspring, irrespective of sex, where one of the parents is affected. This observation confirms the previous conclusion of Breitenbacher that the trait is a pure Mendelian dominant.

The wife of individual 2 in the second generation also comes from a brachymegalodactylous family as indicated by the occurrence of the typical condition in one hand of a brother. Further record of this family could not be obtained.

The appearance of the trait in but one thumb as shown in the third generation, warrants special consideration in the discussion presented at the end of this sketch.

That the twins in family II of the fourth generation are not identical is clearly shown by their general features and further emphasized by a study of the hands. All the thumbs show the characteristic shortness, but the previously mentioned hands of individual 2 are long and slender while those of her sister tend toward plumpness (Figure 13).

Seven individuals in the fifth generation come from parents, one of whom is brachymegalodactylous. In this generation there is no living representative of the trait—a fact which might lead the casual observer to the conclusion that the trait is "dying out." That such is not the case and that the preponderance of normals in this generation is a matter of chance is evident from a study of all generations where the number of normals to abnormals forms an exact 1:1 ratio.

Case II

(*See Chart, Figure* 17)

The conspicuous feature of this line is the inheritance of unilateral brachymegalodactylism through a parent in whom the trait is bilateral. Record of this family was obtained from a single individual (Figure 14) who in turn received some information through correspondence. Completion of the record and determination of the type of inheritance was not feasible under these circumstances.

The blanks, here shown as questionable, do not necessarily represent breaks in the line of inheritance but connecting links of unknown constitution between known manifestations of the trait.

Case III

(*See Chart, Figure* 17)

The record of this case was obtained from individual 4 in the second generation and from an unaffected brother. The father in the first generation is still living at ninety-one years of age and shows no indication of brachymegalodactylism. The informants insist that the mother was likewise unaffected and further state that the condition in the second generation has been caused by numerous "felons." This information is passed without further comment, and here, as in the previous case, the mode of inheritance is undetermined.

No photographs or x-rays of this case were obtained but the external appearances of the trait are identical with those here illustrated.

Case IV

This is in many respects the most remarkable case of all but the record is necessarily brief. All information concerning this case was obtained from

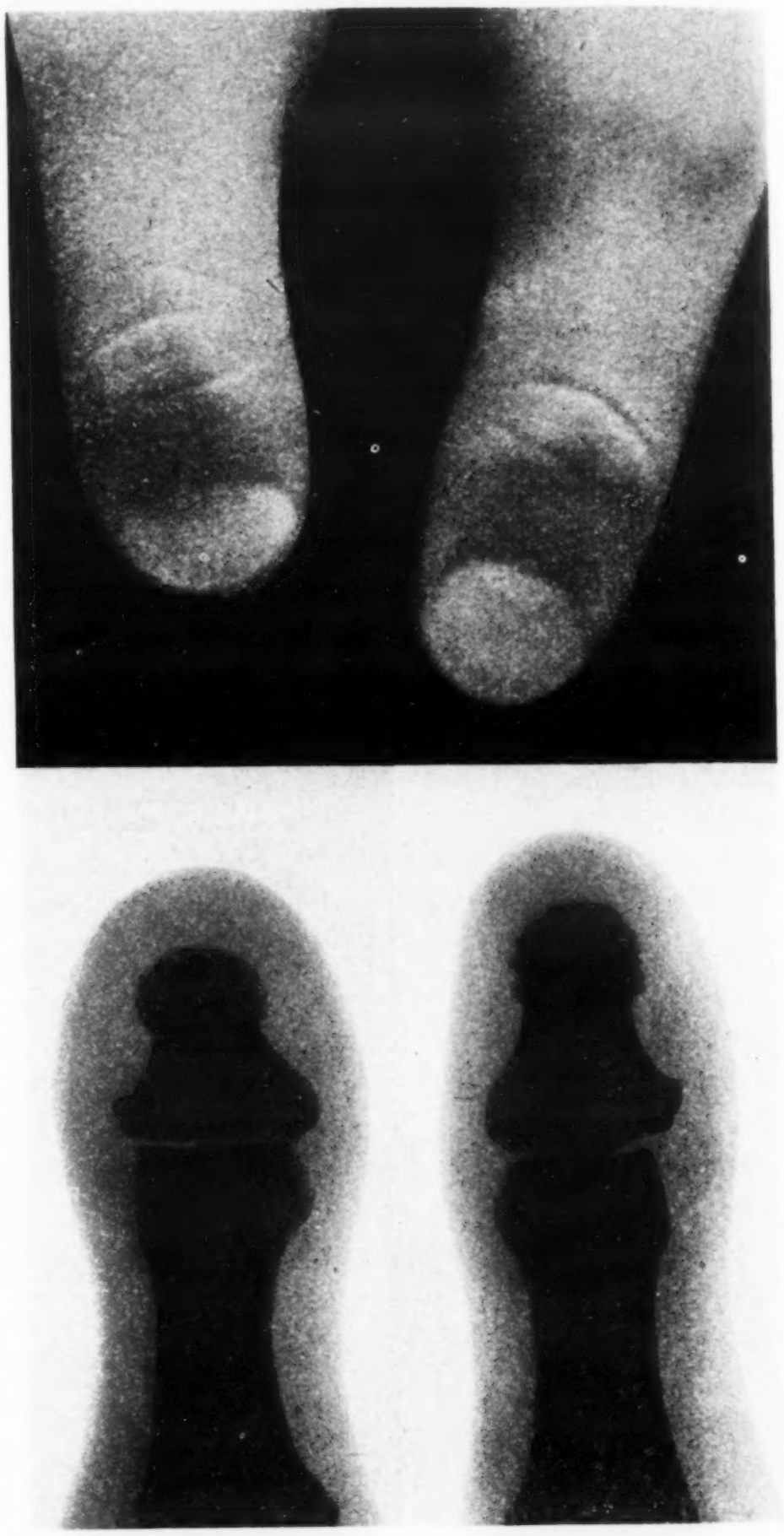
a single subject. The photograph and x-rays (Figure 12) reveal a condition in all respects identical with inherited brachymegalodactylism, yet the trait does not appear elsewhere in the family of five children, in either parent, in any of the grandparents or among any of the numerous aunts, uncles or cousins. From an hereditary standpoint the trait must be considered an original mutation.

Discussion

An x-ray photograph of the brachymegalodactylous hand reveals the fact that the seat of the anomaly lies only in the terminal phalanges of the affected thumbs. This phalanx is short and broad and without exception shows a prominent flare at the tip. A comparison of the x-ray photos of the hands of three unrelated male individuals (Figures 14 and 15) clearly shows the remarkable similarity of the terminal phalanges of the affected thumbs, an observation which establishes beyond question the unit characters conception of the trait.

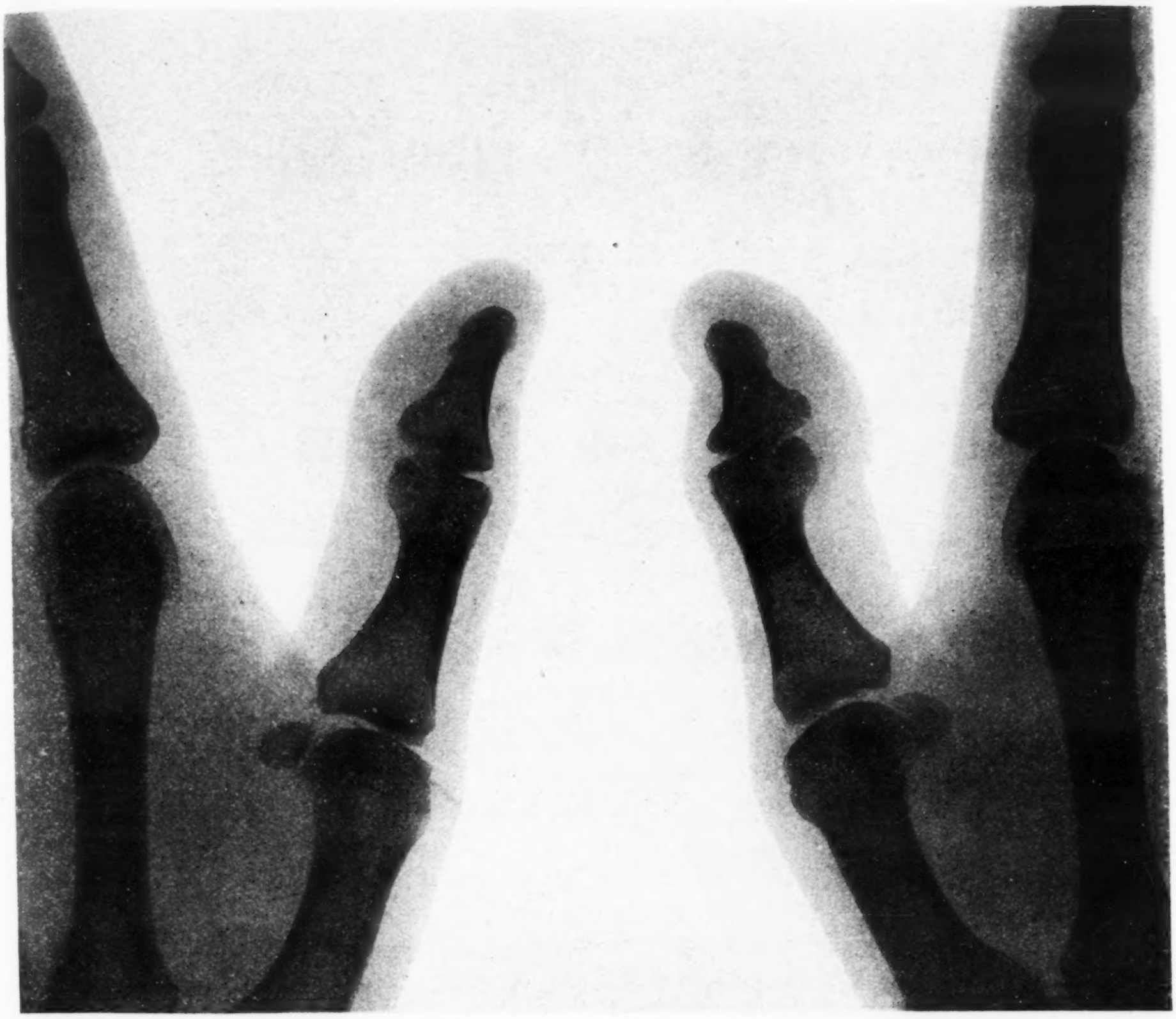
The localization of the dwarfing influence in the terminal phalanx has also been determined by measurements of both normal and affected thumbs. The results of these measurements conform in the main with the conclusions of Breitenbecher who finds that the ratio of the proximal to the distal phalanx of the normal thumb is 1:.74, while in the abnormal thumb it is 1:.41. That the proximal phalanx is of normal length is revealed by actual measurements and by observation of the x-ray figures. This fact is emphasized by two cases where but one hand is affected by brachymegalodactylism—the proximal phalanges in both instances being of equal length. (Figures 13 and 14.)

The appearance of the trait in but one thumb is not readily explained by the existing conceptions of Mendelian heredity. If the bilaterality of the embryo were established by the first cleavage of the zygote, the problem would be simple for, in such an instance, it could be readily assumed that the gene for brachymegalodactyly was undivided and passed to but one of



SHORT THUMBS IN ONE HAND ONLY

Figure 14. Two brothers in this family have only one short thumb, while their mother has both thumbs affected (See chart, Figure 17). This is just the reverse of the case of the twin girls whose mother had only one short thumb (Figure 13). It is not known why this character is inherited unsymmetrically, and the present conception of the mechanism of heredity does not offer a very satisfactory explanation. Certain diseases of the pituitary gland are known to cause asymmetrical skeletal abnormalities, and possibly some of the ductless glands play a part here.

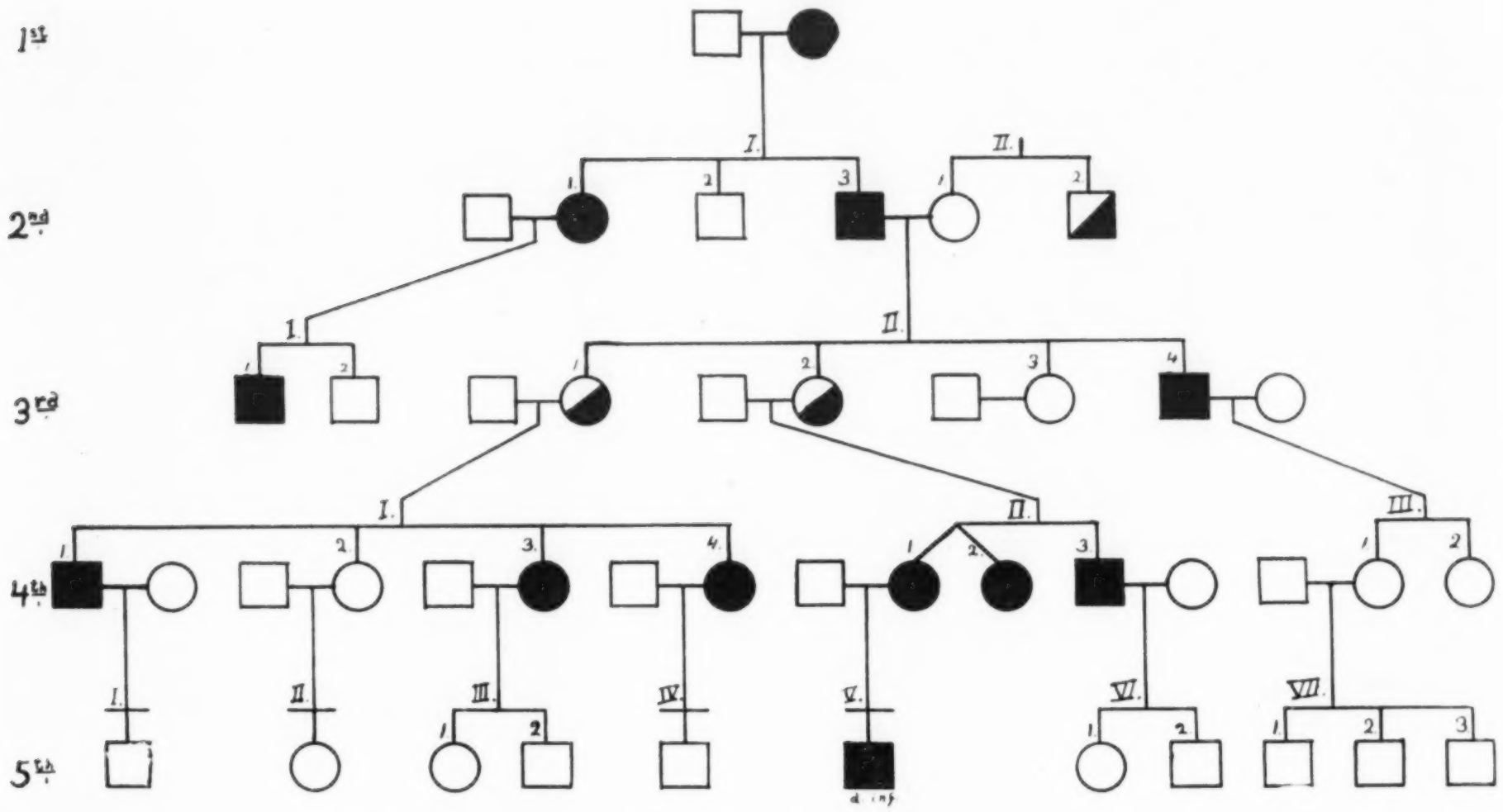


SIDE VIEW OF ASYMMETRICAL THUMBS

Figure 15. These thumbs are also shown in Figure 14. Note that the other two phalanges of these thumbs are not of unequal length, showing that the dwarfing effect of this character is confined solely to the terminal phalange. Nine apparently unrelated lines of brachymegalodactylism were located in this study, indicating that the character is much more widely spread than some other inherited abnormalities of the fingers—fused joints, for instance. Perhaps this is because short thumbs would hardly affect the survival of the individual, where more pronounced abnormalities might do so.

a pair of dividing chromosomes during this first cleavage. All cells on one side of the body would thus contain the determiner for short thumbs and those of the other side, lacking this determiner, would produce a normal thumb. The opposing conception of a gradual establishment of bilaterality at the time of, or in conjunction with, the process of gastrulation, harmonizes less easily with the observed facts, for it is unlikely that an unorganized mass of cells constituting a gastrula would be so divided that all containing the determiner for brachymegadactylism would form one side of an embryo and those lacking this determiner form the other side. A mingling of cells with the determiner and cells without it would certainly result in a more serious derangement of the observable trait than two definite types of brachymegadactylism.

There remains the consideration of the activators and inhibitors which are conceived as regulating the normal development of the embryo. The nature and operation of these influences



FIVE GENERATIONS OF SHORT THUMBS

Figure 16. Squares indicate males, circles females; short thumbed (brachymegalodactylus) individuals are shown in black; appearance of the trait in but one thumb is indicated by one-half black symbols. Individual 2 of family II in the second generation is not related, but comes from a separate line of brachymegalodactylism.

is largely hypothetical but Cushing[2] has shown that the structure of the hand of the adult may be profoundly modified by a disturbed condition of the pituitary gland. This condition is known as dyspituitarism and the fact of its existence leads to a speculation as to the possible influence of the ductless glands upon embryological development. That such an influence might be unilateral in its expression can be supported by analogy from the known behavior of dyspituitary influences.

It is realized that any such conception would only transfer the Mendelian hereditary influences from the observable aspects of the trait to the less definite causal factors.

As before stated, no less than nine separate lines of brachymegadactylism were located in this study. That a mutation should occur so frequently seems inconsistent with the general conception of the stability of species. To explain this upon the basis of an inherent causal factor is to tread upon the forbdiden ground of the inheritance of acquired characters and this sketch must close by presenting a problem rather than a solution.

Acknowledgements are due to all persons who so willingly and ably assisted in the collection of data for this paper, to Dr. Hugh L. Means and his assistant for the x-ray photographs, and to Mrs. E. M. Miller whose knowledge of Greek supplanted the writer's deficiency in that direction.

Summary

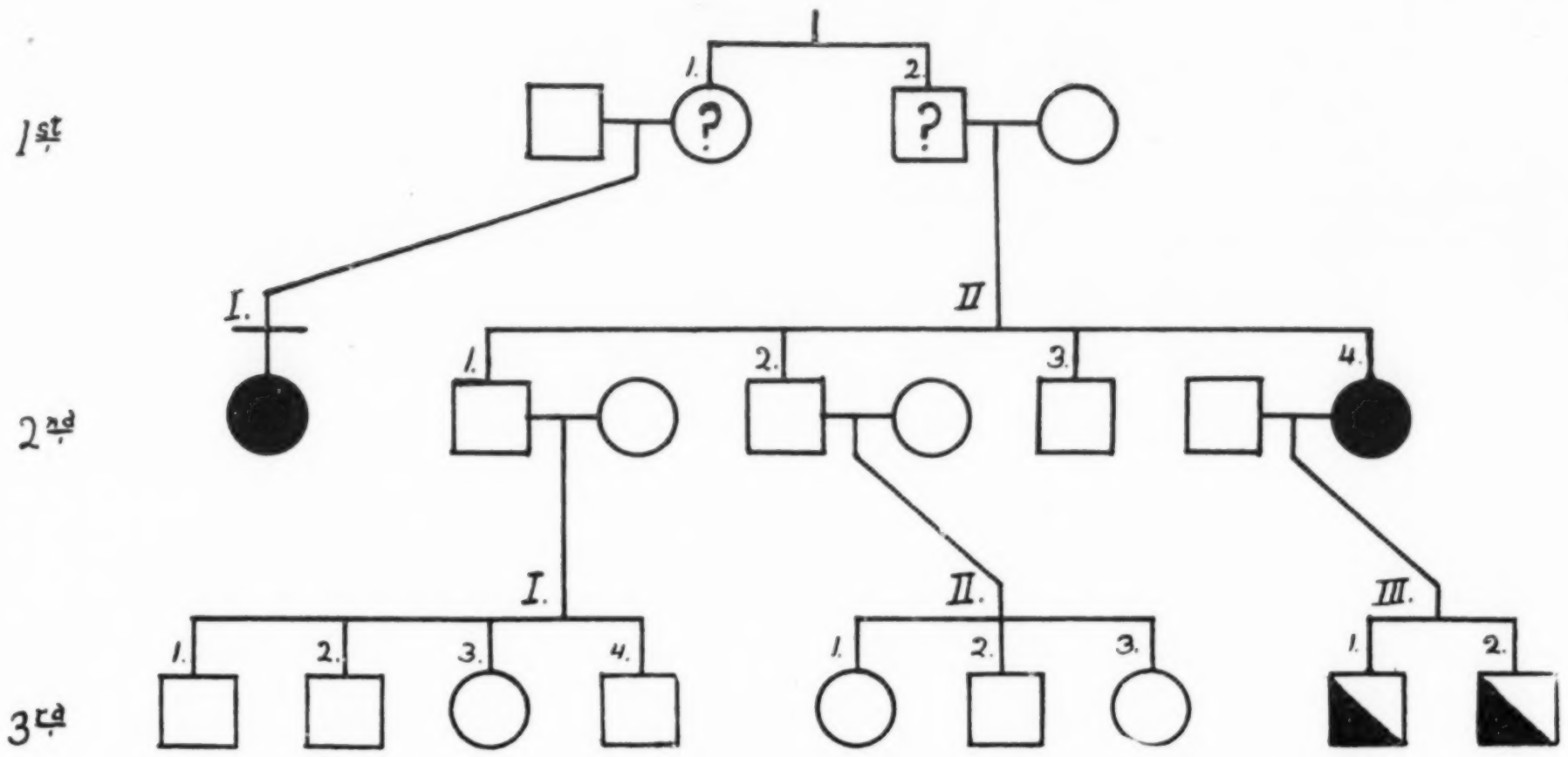
1. Brachymegalodactylism is the condition of having abnormally short thumbs.

2. The trait is believed to be a pure Mendelian dominant.

3. Brachmedalodactylism may affect one or both thumbs without definite ratio.

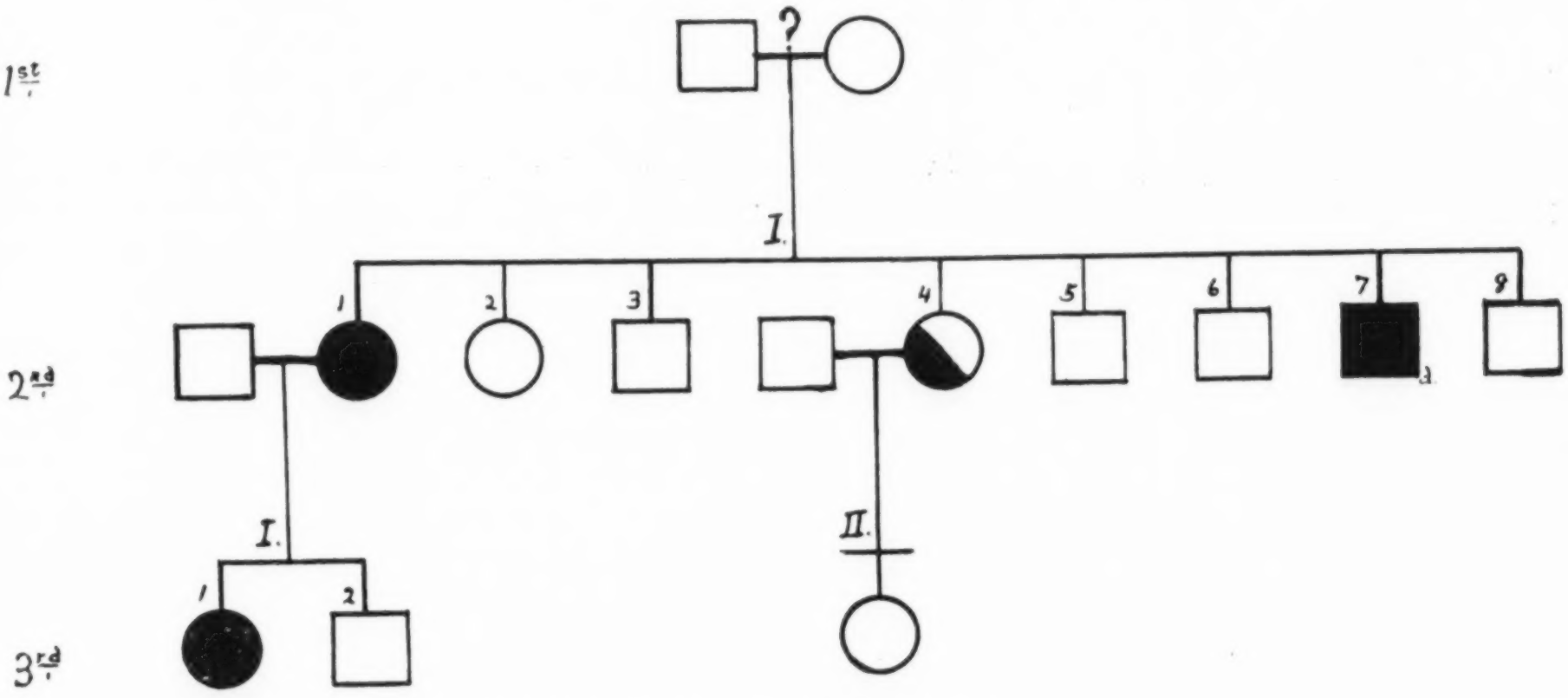
4. One case here reviewed is without hereditary expianation. It may be an original mutation.

5. The seat of the anomaly lies in the terminal phalanx of the affected thumb.



INHERITANCE OF SHORT THUMBS IN ONE HAND ONLY

Figure 17. Symbols used as in Figure 16. Question marks indicate incomplete records.



TWO GENERATIONS OF SHORT THUMBS

Figure 18. Some of the normals in generation II have families, but no record of such was obtained other than to ascertain that no indications of brachymegalodactylism occurred among them.

6. The relation of unilateral brachymegalodactylish to the bilateral development of the embryo is not clear.

7. The location of nine unrelated cases of the trait without extended effort seems inconsistent with the general conception of the stability of species.

Literature Cited

1 Breitenbecher, J. K. Hereditary Shortness of Thumbs. *Journal of Heredity*, Vol XIV, No. 1. 1923.

2 Cushing, Harvey. *The Pituitary Body and Its Disorders*, pp. 28 and 253. 1912.

A Special Invitation

This year the American Association for the Advancement of Science is offering special inducements to members of affiliated organizations to become members of that Association. For the rest of this year all members of the American Genetic Association are therefore eligible to join the A. A. A. S. without the payment of the usual five dollar entrance fee.

Annual dues in the A. A. A. S. are five dollars. Members receive either the weekly magazine, *Science*, or the *Scientific Monthly*, as they prefer. Subscription to either of these is worth the amount paid in dues, and in addition membership carries with it a number of other privileges. Application for membership should be made to the Permanent Secretary, Dr. Burton E. Livingston, Smithsonian Institute, Washington, D. C. The Secretary will also be glad to send a booklet of information about the A. A. A. S. and sample copies of the magazines to those who are interested.

Since this offer is only open for a short time longer and will not be made again for several years, members of this Association who desire to avail themselves of it are urged to do so without delay.

The Breeding of Fodder Plants

HANDBUCH DER LANDWIRTSCHAFTLICHEN PFLANZENZUECHTUNG, by C. FRUWIRTH. 2nd volume, 5th edition; Die Zuechtung von Mais, Futterruebe und anderen Rueben, Oelpflanzen und Graesern. Prof. an der Technischen Hochschule, Wien. Pp. 256 with 56 illus., price $3.00. Berlin, Verlagsbuchhandlung Paul Parey, 1924.

Dr. Fruwirth's encyclopedic work on plant-breeding has long been recognized as the standard, as its many editions indicate. The second volume, which now appears in a new revision, deals with grasses (including maize) and root crops used for fodder, and also with oil-plants such as the sunflower. The sections on maize and stock beets show the greatest changes, in comparison with the fourth edition; the treatment of rutabaga, of poppies (as oil producers), and of various grasses has also been revised. The work needs no recommendation—it is indispensable to plant breeders. P. P.